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NEW SPECIES OF CRINOIDS FROM ILLINOIS AND OTHER STATES.

BY S. A. MILLER AND WM. F. E. GURLEY.

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NEW SPECIES OF CRINOIDS FROM ILLINOIS AND OTHER STATES.

BY S. A. MILLER AND WM. F. E. GURLEY.

SUBKINGDOM ECHINODERMATA.

CLASS CRINOIDEA.

ORDER PALÆOCRINOIDEA.

FAMILY ACTINOCRINIDÆ.

BATOCRINUS NODOSUS, n. sp.

Plate I, Fig. 1, azygous side; Fig. 2, opposite view; Fig. 3, summit view.

Body rather above medium size, calyx obconoidal, broadly truncated below, about one-third wider than high; arm openings directed nearly horizontally. Plates very tumid, the larger ones subspinous; surface finely granular.

Basals form an hexagonal disc with slight re-entering angles. The plates are very thick and the cavity for the attachment of the column deep. First radials a little wider than long, three hexagonal, two heptagonal. Second primary radials quite small, quadrangular and from two to three times as wide as high. Third primary radials more than twice as large as the second, rather long, pentagonal, axillary, and bear upon each superior sloping side two secondary radials. The second secondary radials are axillary, and in three of the rays, bear upon each superior sloping side the tertiary radials. In some rays there are two tertiary radials and in others only a single long tertiary radial, which gives to each of these rays four arms. The distal side of each ray, adjoining the azygous area, is constructed in this same way, but the proximal side of each bears

EXCHANGE
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an axillary, tertiary radial that supports upon one side a single quaternary plate, and upon the other two quaternary plates, which arrangement gives to each of these rays five arms. There are, therefore, twenty-two arms in this species.

In two of the regular interradial areas there is only a single large plate, in each of the other areas there are two plates, one large, the other quite small. The azygous area contains four large plates and two very small ones. The first one is in line with the first primary radials and rather longer than either of them. It is followed by three large plates, subequal in size, in the second range, and above these, on the left of the central plate, there are two small plates. The azygous area is entirely cut off from the plates of the vault by the union of the quaternary radials.

The vault is moderately convex and covered with polygonal, highly convex, and nodose plates and bears a large subcentral proboscis.

This species is distinguished by its general form, twenty-two arms, nodose and subspinous plates and interradial areas. Heretofore, there have been described, from the Burlington Group, ten species, having twenty-two arms, and probably *F. proximus* is as nearly related to this as any other species though the calyx is much shorter and the radials differently formed, and yet there are more regular and azygous plates in the several areas than in this species. The two species cannot be confounded by any one capable of understanding the structure of crinoids.

Found by C. S. Hodgson, in the Burlington Group, in Adams county, Illinois. and now in the collection of S. A. Miller.

BATOCRINUS NODULOSUS, n. sp.

Plate I, Fig. 4, basal view; Fig. 5, azygous side of calyx; Fig. 6, opposite view of calyx.

Body medium or above medium size. Calyx broadly truncated below, obconoidal, twice as wide as high, arm openings directed upward at a slight angle. Plates spinous. The hexagonal second primary radials, two platés in the second range, in the azygous area, and the sculpturing bring this species near *Actinocrinus*. The interradial areas, are, however, cut off from the vault, and the hexagonal second primary radials are due rather to the number of interradials than to the usual lengthening of the calyx, which induce us to refer the species to *Batocrinus.*

The basal plates form a thin hexagonal disc with slight reentering angles. The disc is only gently concave for the attachment of the column, and the columnar canal is quite large. Each basal plate bears two nodes or short spines that are directed downward. First radial large, wider than long, three hexagonal, two heptagonal, and each one is produced in the form of a wedge-shaped spine. The second primary radials, differ somewhat in size, about one-half wider than long, hexagonal, by reason of a slight truncation of the superior angles by the interradials, and each one bears a central node. Third primary radials smaller than the second, pentagonal, axillary, each bears a central node and supports upon each upper sloping side a single secondary radial, which is axillary and supports, in four of the rays, upon each upper sloping side, a single tertiary radial, which gives to each of these rays four arms. In one of the lateral rays, the third primary radial supports, upon one side, an elongated secondary radial, with a deeply concave facet for the reception of the first arm plate, and upon the other an axillary secondary radial, which supports upon each upper side a single tertiary radial, which arrangement gives to this ray three arms. There are, therefore, nineteen arms in this species.

In one of the regular interradial areas there are five plates, one in the first range, two in the second range, and two in the third range. In each of the other three regular interradial areas there are four plates, one in the first range, two in the second range, and one in the third range. In the azygous area there are seven plates, the first one is in line with the first primary radials and fully as large and spinous as either of them. It is followed by two large spinous plates in the second range, three smaller plates in the third range, and one small depressed plate in the fourth range, that sends an angle high between the tertiary radials and reaches an angle, in a plate, that connects with the vault plates above the summit of the tertiary radials. The last plate mentioned is in part a plate belonging to the calyx, but its superior faces are higher than the ambulacral furrous and unite with plates belonging to the vault. The vault is unknown.

This is a peculiar species that will, at once, be distinguished, by the spinous plates, nineteen arms, and numerous interradials.

Found by C. S. Hodgson in the Burlington Group, in Adams county, Illinois, and now in the collection of S. A. Miller.

BATOCRINUS SALEMENSIS, n. sp.

Plate I, Fig. 10, basal view; Fig. 11, summit: Fig. 12, azygous side.

Species small, vault and calyx subequal, depressed, biturbinate. Calyx saucer-shaped, between two and three times as wide as high. Plates convex, radial series somewhat angular. Ambulacral openings directed horizontally.

Basal plates form an hexagonal disc one-half wider than the diameter of the column and having a height equal to about one-fourth the diameter of the column. The depression for the attachment of the column is hemispherical. The first primary radials are between two and three times as wide as long, three hexagonal, two heptagonal. Second primary radials quadrangular, short, from three to five times as wide as long. Third primary radials only a little larger than the second, from three to four times as wide as long, pentagonal, axillary, and, in four of the rays, bear upon each upper sloping side two secondary radials the last ones of which are axillary and bear upon each upper sloping side two tertiary, which gives to each of these rays four arms. In the ray opposite the azygous area, the third primary radial bears upon each upper sloping side three secondary radials, which gives to it two arms. There are, therefore, eighteen arms, in this species, and eighteen ambulacral openings to the vault.

In each of two of the regular interradial areas there are three plates, one large followed by two small plates. In each of the other two areas there are only two plates, one large plate followed by one plate in the second range. In the azygous area there are six plates. The first one is in line with the first primary radials and nearly as large, it is followed in the second range by three plates, above which there are two plates. One is above the middle plate and the other is to the right of it.

The vault is moderately convex, covered with polygonal spinous plates, and bears a subcentral proboscis. No ovarian pores have been discovered.

This species is distinguished among the eighteen armed species, by its general form, surface ornamentation, two secondary radials, and by the interradial and azygous areas.

It was found in the Warsaw Group, at Salem, Indiana, and is now in the collection of Charles L. Faber.

BATOCRINUS STELLIFORMIS, n. sp.

Plate I, Fig. 13, basal view; Fig. 14, azygous side; Fig. 15, summit.

Species below medium size, depressed, biturbinate. Calyx broadly rounded below, about three times as wide as high. Radial ridges slightly defined and each series projecting so as to give it a stellate outline. Ambulacral openings directed upward and not visible from a basal view. Plates plane and smooth.

Basal plates form a low cup, hexagonal, with a slight reentering angle on the azygous side, diameter one-half greater than the diameter of the column. Depression for the attachment of the column, moderately concave. First primary radials large, a little wider than long, three hexagonal, two heptagonal. Second primary radials short, quadrangular, three or four times as wide as long. Third primary radials about one-half larger than the second, three times as wide as long, pentagonal, axillary, and, in four rays, bear upon each upper sloping side two secondary radials, the last ones of which are axillary and bear upon each upper sloping side two tertiary radials, which gives to each of these rays four arms. In the ray opposite the azygous area, the third primary radial bears upon each upper sloping side three secondary radials, which gives to it two arms. There are, therefore, eighteen arms in this species, and eighteen ambulacral openings to the vault.

All of the interradial areas connect with the vault. There are four plates in each regular interradial area, one in the first range, two in the second, and one in the third, which separates the radial series and unites with the plates of the vault. There are fourteen plates in the azygous area. The first one is in line with the first primary radials and of about the same size; it is followed by three plates in the second range, six plates in the third range, and four in the fourth range, two of which unite with the plates of the vault. One of the four plates, in the last range, is to the left and another is intercalated between the lower part of the two larger plates that unite with the plates of the vault.

The vault is depressed, convex and covered with small, convex, polygonal plates and has a subcentral azygous orifice slightly elevated above the greatest convexity of the vault, but it could hardly be regarded as a proboscis. No ovarian pores can be discovered.

This is a very peculiar species and so different from all other eighteen-armed species that no comparison with any of them is necessary.

Found by F. A. Sampson, in the Keokuk Group, at Boonville, Missouri, and now in his collection.

BATOCRINUS SIGNATUS, n. sp.

Plate I, Fig. 16, azygous side; Fig. 17, opposite view.

Species medium or below medium size, biturbinate. Calyx broadly truncated, obpyramidal, about twice as wide as high. Radial ridges angular and well defined. Interradial areas flattened. Ambulacral openings directed a little above a horizontal line.

Basals form an hexagonal disc that is expanded in rim around the base of the calyx. Diameter a little greater than the diameter of the column, and height about equal to the thickness of the plates. Shallow concave depression for the attachment of the column. First primary radials a little wider than long, longitudinally angular in the middle part, three hexagonal, two heptagonal. Second primary radials short, quadrangular, three or four times as wide as long. Third primary radials one-half larger than the second, more than twice as wide as long, pentagonal, axillary, and in the ray on the left of the azygous area, and in each lateral ray, bear upon each superior sloping side two secondary radials, the last ones of which are axillary and support on each upper side two tertiary radials, which gives to each of these rays four arms. In the ray on the right of the azygous area there are three secondary radials on the distal side, and two on the proximal side, the last one being axillary and supporting on one upper side a single tertiary radial and on the other two tertiary radials, which gives to this ray three arms. In the ray opposite the azygous area, the third primary radial bears upon each upper side three secondary radials which gives to this ray two arms. There are, therefore, seventeen arms and seventeen ambulacral openings to the vault in this species.

All of the interradial areas connect with the vault and are depressed between the rays. In each regular interradial area there are four plates. The first one is large, it is followed by two plates, in the second range, and by one elongated plate, in the third range, that unites with the plates of the vault. In the azygous area there are eleven plates. The first one is in line with the first primary radials and about as large. It is followed by three plates in the second range. three in the third range, two in the fourth range, and two in the fifth range that unite with the plates of the vault.

Vault conoidal and covered with small, polygonal, convex plates and bearing a very small subcentral proboscis. No ovarian pores have been detected.

This is a marked species so different from all other seventeen-armed species that occur in rocks of the same age that no comparison with any of them is necessary.

Found by N. K. Burkett in the Keokuk Group, at Keokuk, Iowa, and now in the collection of Wm. F. E. Gurley.

BATOCRINUS STRENUUS, n. sp.

Plate I, Fig. 18, azygous side; Fig. 19, side view.

Species small but bearing large and vigorous arms, biturbinate. Calyx bowl-shaped, about twice as wide as high. No radial ridges. Plates convex.

Basals form an hexagonal disc more than one-half wider than the diameter of the column. First primary radials very large, about as high as wide, three hexagonal, two heptagonal. Second primary radials quadrangular, from three to four times as wide as long. Third primary radials a little larger than the second, about three times as wide as long, pentagonal, axillary, and in three of the rays bear upon each upper sloping side two secondary radials, which gives to each of these rays two arms. In each ray adjoining the azygous area there are two secondary radials on the distal side of the third primary radial and two on the proximal side, the last being axillary, which gives to each of these two rays three arms. There are, therefore, twelve arms in this species. The arms are very strong and, above the first two or three cuneiform plates, are composed of a double series of interlocking plates as is usual in this genus The arms are subfusiform and slightly flattened at the superior ends.

There is one plate in each of the regular interradial areas. The first azygous plate is in line with the first primary radials and the largest plate in the body. It is followed by three plates in the second range which separate the secondary radials and unite with three plates belonging to the vault.

The vault is conoidal. Proboscis not exposed in our specimen.

This is the second species ever described from the Keokuk Group having twelve arms. The other is *B. prægravis*, to which this one has no resemblance. This species is distinguished by its general form, twelve arms and wide azygous area and cannot be mistaken for any other.

Found in the Keokuk Group, at Boonville, Missouri, and now in the collection of Wm. F. E. Gurley.

BATOCRINUS DELICATULUS, n. sp.

Plate 1, Fig. 20, azygous side of a specimen somewhat compressed magnified two diameters; Fig. 21, opposite side view of same magnified two diameters.

Species very small and delicate, somewhat biturbinate. Calyx obpyramidal, twice as wide as high. Plates convex, more or less angular. Radial ridges well defined, interradials depressed, and all the interradial areas connect with the vault.

Basal plates form an hexagonal disc which is nearly covered with the end of the column. First primary radials large, about as high as wide, three hexagonal, two heptagonal. Second primary radials quadrangular, from three to four times as wide as long. Third primary radials one-half larger than the second, between two and three times as wide as long, pentagonal, axillary, and on the distal side of each one adjoining the azygous area bears a secondary radial that supports a free arm, and on the proximal side two secondary radials, the last ones being axilliary, which arrangement gives to each of these rays three arms. In each of two lateral rays the third primary radial supports two secondary radials, the last ones being axillary, which gives to each of these rays four arms. In the ray opposite the azygous area the free arms arise from each single secondary radial, which gives to this ray two arms. There are, therefore, sixteen arms in this species. The arms are composed of rounded cuneiform plates for about one-fifth part of their length, above which they are composed of a double series of interlocking plates and gradually flatten toward the superior ends.

There is a single regular interradial in each area and it connects with the plates of the vault. The first azygous plate is in line with the first primary radials and fully as large as any of them. It is followed in the second range by three plates and these unite with the plates of the vault.

The vault is convex. Proboscis not exposed in our specimen.

This is the twelfth species described from the Keokuk Group that bears sixteen arms, but it is readily distinguished from each of them by its general form and by the interradial plates and structure of the arms. It is a marked species and though our specimen is small, it is quite distinct and not the young of any described species.

Found in the Keokuk Group, at Boonville, Missouri, and now in the collection of F. A. Sampson, of Sedalia, Mo.

BATOCRINUS REGALIS, n. sp.

Plate I, fig. 22, basal view; Fig. 23, azagous side; Fig. 24, summit.

Species rather above medium size, depressed, biturbinate or somewhat lenticular. Calyx very rapidly spreading from a moderately rounded base, and having a diameter nearly three times as great as the height. Plates convex. No radial ridges. Surface granular. Arm openings directed a little above a horizontal line and not visible in a basal view.

Basals form an hexagonal disc very little larger than the diamater of the column and having an hemispherical depression for the attachment of the column. An angular low ridge surrounds the columnar depression. First primary radials very convex, unequal in size, from one-third to two-thirds wider than long, three hexagonal and two heptagonal. Second primary radials guadrangular, from two to three times as wide as long. Third primary radials very little larger than the second, more than twice as wide as long, pentagonal, axillary and support on each upper sloping side two secondary radials the last of which is axillary, and, in the rays adjoining the azygous area, and, in the left lateral ray, each proximal upper sloping side bears two tertiary radials and each distal side bears a single tertiary radial which is axillary, and supports upon each upper sloping side two quarternary radials, which arrangement gives to each of these three rays six arms. In the right lateral ray one side only bears quaternary radials as in the arms above described, and, on the other side, the last secondary radial supports, on each upper side, two tertiary radials, which gives to this ray five arms. In the ray opposite the azygous area the last secondary plates bear upon each upper side two tertiary radials, which gives to this ray four arms. There are, therefore, in this species, twenty-seven arms and twenty-seven ambulacral openings to the vault.

The interradial areas are cut off from the vault by the union of the quaternary and tertiary radials. In the regular interradial areas there are only two plates, one large plate followed by a much smaller one. In the azygous area there are five plates. The first plate is in line with the first primary radials and of about the same size; it is followed by three plates, in the second range, and above these there is intercalated a single plate which is below the union of the first quaternary plates.

Vault moderately convex and covered with polygonal convex and tumid plates. The proboscis is subcentral, but it is broken away from our specimen.

This is the first *Batocrinus* ever described, having twenty-seven ambulacral openings to the vault, and, consequently, the arm formula alone distinquishes it from all other species. It is peculiar also in its form and azygous plates.

Found by F. A. Sampson in the Burlington Group, at Sedalia, Missouri, and now in his collection.

BATOCRINUS NITE~~N~~nS, n. sp.

Plate I, Fig. 30, basal view; Fig. 31, azygous side; Fig. 32, opposite view.

Species medium size, biturbinate. Calyx moderately truncated, obconoidal, in the lower part, and rapidly spreading near the arms, which are directed horizontally, and the radial series project beyond the interradial areas so as to give it a stellate outline. No radial ridges. Plates without ornamentation. Sutures distinct.

Basal plates form a low cup, having a height about equal to half the diameter of the base, which is truncated only the size of the column. Depression for the attachment of the column moderately concave. Columnar canal small. First primary radials large, wider than long, three hexagonal, two heptagonal. Second primary radials quadrangular, and about twice as wide as long Third primary radials a little larger than the second, about twice as wide as long, pentagonal, axillary and, in the two rays adjoining the azygous area, bear upon the proximal sides two secondary radials, the last of which are axillary and support upon each superior sloping side two tertiary radials, and bear upon each distal side three secondary radials, which gives to each of these rays three arms. In each lateral ray the third primary radials support on each upper sloping side two secondary radials, the last being axillary and supporting on each superior side two tertiary radials, which gives to each of these rays four arms. The ray opposite the azygous area bears upon each upper side three secondary radials, which gives to it two arms. There are. therefore, sixteen arms in this species. The arm formula is 3+4+2+4+3.

All of the interradial areas connect with the vault. There are five plates in each of two regular interradial areas, one in the first range, two in the second, and two in the third. the longer one of which unites with the plates of the vault. In each of the other two regular interradial areas there are six plates, one in the first range, two in the second and three in the third, one of which connects with the vault in one area and two in the other. In the intersecondary area, in the ray on the right of the azygous area, there is a plate inserted that connects with the plates of the vault. The azygous area is subelliptical in outline, and contains fourteen plates. The first one is in line with the first primary radials and of about the same size, it is followed by three plates in the second range, the middle one of which is much the largest. There are five plates in the third range, and an intercalated plate over the last one, on the left side. There are two small elongated plates in the fourth range by the side of the upper part of the largest plate, in the third range, which gives us three plates in width at this point, all of which unite with two elongated plates that unite with the plates of the vault. The last two plates unite with a first tertiary radial on the left and a second tertiary radial on the right and then extend up over part of the vault.

The vault is convex and covered with numerous convex, polygonal plates and bears a subcentral proboscis. The interradials are depressed toward the margin. There is an ovarian pore on each side of each pair of arms and on each side of each single arm, which gives to this species eighteen ovarian apertures.

There has never been but four sixteen-armed species heretofore described from the Burlington Group, and neither one of them has any resemblance to this species. This species is, therefore, distinguished by its arm formula, general shape, and regular interradial areas and azygous area.

Found in the Burlington Group, at Burlington, Iowa, and now in the collection of Wm. F. E. Gurley.

BATOCRINUS PARILIS, n. sp.

Plate II, Fig. 1, view of an entire specimen; Fig. 2, azygous view of the calyx.

Species medium size, very symmetrical, biturbinate. Calyx obconoidal, about twice as wide as high, truncated only the size of the column. No radial ridges. Surface smooth or very finely granular.

Basals form a low cup one-half wider than the diameter of the column. First primary radials one-third wider than long, three hexagonal, two heptagonal. Second primary radials quadrangular, three times as wide as long. Third primary radials a little larger than the second, pentagonal, axillary and in the ray on each side of the azygous area bear on the distal sides three secondary radials and on the proximal sides two secondary radials, the last of which are axillary and support on one upper side a single tertiary radial and upon the other two tertiary radials, which gives to each of these rays three ambulacral openings to the vault. In each of the lateral rays the third primary radial supports on each upper side two secondary radials, the last being axillary and supporting on each upper side a tertiary radial, which gives to each of these rays four ambulacral openings to the vault. In the ray opposite the azygous area the third primary radial supports on each upper sloping side three secondary radials, which gives to this ray two ambulacral openings to the vault. There are, therefore, sixteen ambulacral openings to the vault in this species. The arms bifurcate on the first plate and hence there are thirty-two arms in this species. The arms are composed of a double series of interlocking plates from the beginning and flatten toward the superior ends and become longitudinally concave, as shown in the illustration.

None of the interradials connect with the plates of the vault. There are three plates in each regular interradial area, one large followed by two smaller ones. There are six plates in the azygous area. The first one is in line with the first primary radials and about the same size. It is followed, in the second range, by three large plates, subequal in size, and these are followed in the third range by two small plates directly over the middle plate in the second range.

The vault is conoidal and about as large as the calyx. It is covered with smooth, polygonal plates and bears a long, small central proboscis.

This species is distinguished by the smooth plates of both the calyx and vault, by the sixteen ambulacral openings, with a formula of 3+4+2+4+3, and thirty-two arms. It is further distinguished by the six plates in the azygous area. Only three species have been, heretofore, described from the Keokuk Group with thirty-two arms, and none of them resemble this one. There have been fifteen species described from the Keokuk Group with sixteen arms and possibly one or two of these have thirty-two arms, but they are ornamented species bearing radial ridges and have little resemblance to this one. It is unnecessary to make any comparison with any other species.

Found in the Keokuk Group, at Boonville, Missouri, and the specimen having the arms with other specimens are in the collection of Wm. F. E. Gurley, and the one showing the vault and others are in the collection of S. A. Miller. It preserves part of the arms opposite to the side illustrated.

REMARKS.—The arms flatten as they approach the superior ends and when they curve in or infold toward the vault they become longitudinally concave in all the specimens. This is another illustration of the futility of undertaking to establish genera on the character of the arms, for if you can do so, this would belong to *Eretmocrinus* or to a new genus, according to the taste of the author.

BATOCRINUS FABERI, n. sp.

Plate II, Fig. 3, azygous side; Fig. 4, opposite view.

Body rather below medium size and somewhat biturbinate or wheel-shaped, though the calyx is decidedly larger than the vault. Calyx truncated below and slowly expanding to the third radials and then abruptly spreading to the free arms. Arm openings directed horizontally. Twice as wide as high. No radial ridges. Plates slightly convex in the superior part and tumid below. Surface granular.

Basals short and form a low subhexagonal disc, with slight re-entering angles. The disc is about one-fourth wider than the diameter of the column and bears a shallow concave depression for the attachment of the column. and a small round columnar canal. First radials a little wider than long, three hexagonal, two heptagonal. Second radials quite small, quadrangular, and three or four times as wide as long. Third primary radials about twice as large as the second, pentagonal, axillary and bear upon each upper sloping side two secondary radials, the last one being axillary, and supporting in some rays a single tertiary radial and in others two tertiary radials, which arrangement gives to each ray four arms. There are, therefore, twenty arms in this species and twenty ambulacral openings to the vault.

There are two plates in each regular interradial area, the first one large and tumid, the second one much smaller. There are five plates in the azygous area. The first one is in line with the first primary radials and rather larger than either of them. It is followed by three plates in the second range, the middle one being the smallest and quadrangular. Above the middle plate there is a smaller and wider plate. The plates in the azygous area look very much like the three primary radials in a radial series, and the first regular interradial on each side of the quadrangular middle plate, as shown in the illustrations. No ovarian pores can be detected.

The vault is convex, without interradial depressions and covered with polygonal convex plates. It bears a subcentral proboscis.

This species is distinguished among those bearing twenty arms, by its general form and by the azygous plates.

It was found in the Burlington Group, in Adams county, Illinois, and is now in the collection of Charles L. Faber.

BATOCRINUS PETTISENSIS, n. sp.

Plate II, Fig. 5, azygous side; Fig. 6, opposite view.

Species medium size, biturbinate, calyx and vault subequal. Calyx rather broadly truncated, obconoidal, most expanded opposite the azygous area, arm openings directed nearly horizontally, but not visible in a basal view. No radial ridges. Plates highly convex or tumid.

Basal plates form an hexagonal disc that bears an hemispherical depression for the attachment of the column, and has a diameter one-half greater than the diameter of the column.

First primary radials wider than long, very tumid, three hexagonal, two heptagonal. Second primary radials small, quadrangular, three or four times as wide as long. Third primary radials twice as large as the second, pentagonal, axillary, and support on each upper sloping side two secondary radials, the last of which are axillary and support on each upper sloping side two tertiary radials, except in the arms adjoining the azygous area where there are three, which arrangement gives to each ray four arms. There are, therefore, twenty arms in this species.

None of the interradial areas connect with the vault. There is a single plate in the regular interradial area, on the right of the azygous area, and two plates in each of the other regular interradial areas, the first one large, the second one smaller. Azygous area subovate and contains eight plates. The first one is in line with the first primary radials and fully as large. It is followed by three plates in the second range, three plates in the third range, and one small plate in the fourth range, which is cut off from the vault by the third tertiary radials.

The vault is convex and covered with tumid polygonal plates, and bears a rather large subcentral proboscis.

This species is distinguished from all other twenty-armed species by the third tertiary radials adjoining the azygous area and by the form of the azygous area and the number of plates it contains. It is unnecessary to carry the comparison further.

Found in the Burlington Group, at Sedalia, Missouri, and now in the collection of F. A. Sampson.

BATOCRINUS SPURIUS, n. sp.

Plate II, Fig. 7, one of the azygous sides; Fig. 8, the other azygous side; Fig. 9, opposite view.

The specimen to which we have attached the name above is medium size, robust, has only four rays, eighteen arms and two azygous areas. If it is abnormal, we are unable to refer it to any described species, and as it is extraordinary and bears no evidence of ever having been injured, we think we are justified in giving it a name and describing it.

It is biturbinate. Plates convex or tumid.

Basals stand upright, and form a cup, about one-half wider than the diameter of the column, having a height equal to about one-third of the diameter, rather deeply notched at the sutures and having a hemispherical depression for the attachment of the column. Columnar canal cinquefoil. First primary radials unequal in size, wider than long, three hexagonal, one heptagonal. Second primary radials four times as wide as long, quadrangular. Third primary radials three or four times as large as the second, pentagonal, axillary, and in two of the rays support on each upper side two secondary radials, the last being axillary and supporting on each upper side two tertiary radials, which gives to each of these rays four arms. In the other two rays, one of which is on the left of an azygous area and the other between the azygous areas, there is on one side of the third radials two secondary radials, the last being axillary and supporting two tertiary radials, and on the other side a secondary radial which is axillary and supports on one side two quaternary radials and upon the other a tertiary radial which is axillary and supports two quaternary radials, which arrangement gives to each of these rays five arms. There are, therefore, eighteen arms in this species.

In each of the two regular areas there are two plates, one large followed by a smaller one. In one azygous area there are six plates and in the other seven. The first is in line with the first primary radials and of about the same size. It is followed, in the second range, by three plates and in the third range by two plates in one area and three in the other.

Vault convex and covered by tumid, polygonal plates and bears a rather large subcentral proboscis.

Found in the Burlington Group, at Burlington, Iowa, and now in the collection of A. Albers, of Cincinnati.

REMARKS.—There have been described one hundred and seventy-seven species of *Batocrinus*, from the Subcarboniferous rocks of North America, and none from rocks higher or lower, in the Geological scale, if we except *Actinocrinus praecursor*, Hall, from the Hamilton Group, which has been referred to *Dorycrinus*, by some authors, and may be a *Batocrinus* or belong to some other genus. It is certainly not an *Actinocrinus*, and we see no reason to think it is a *Dorycrinus*, but the basal and radial series are the same as in *Batocrinus*. Of these one hundred and seventy-seven species, twenty-four have been referred to *Eretmocrinus*, which genus we have elsewhere shown is based upon an association of peculiar specific characters, one or more of which belongs to ordinary *Batocrinus*, and each of which occurs in species undoubtedly referable to *Batocrinus*. Beside, *Eretmocrinus* is only found associated with *Batocrinus*, from the Burlington to the Warsaw Group.

Three species only have been described from the Kinderhook Group or rocks below the Burlington and each of these possessed twenty arms, and only two from the Kaskaskia Group, one of which possessed eighteen and the other twenty arms.

In the Burlington Group they are found with eight, ten, twelve, thirteen, fourteen, fifteen, sixteen, seventeen, eighteen, nineteen, twenty, twenty one, twenty-two, twenty-three, twenty-four, twenty-six and twenty-seven arms. In all the range of arm formulas from eight to twenty-seven only nine, eleven and twenty-five are unknown. The most numerous species possessed eighteen, twenty and twenty-two arms.

In the Keokuk Group they are found with twelve, fourteen, fifteen, sixteen, seventeen, eighteen, nineteen, twenty, twenty-one, twenty-two, twenty-four, twenty-five, twenty-six, twenty-eight, twenty nine, thirty, thirty-two, thirty-three, thirty-six and forty arms. The most numerous species possessed sixteen, seventeen, eighteen, twenty and thirty-two arms. In all the range of arm formulas from twelve to forty only thirteen, twenty-three, twenty-seven, thirty-one, thirty-four, thirty-five and thirty-seven to thirty-nine are unknown.

In the Warsaw and St. Louis Groups they are found with seventeen, eighteen, twenty and forty arms. The most numerous species possessed eighteen and twenty arms.

It will be noticed that while no species has been described from the Burlington Group with twenty-five arms, some have been described with that number in the Keokuk. It must be borne in mind too that some species have been imperfectly described without giving the arm formula, and it may be that the few missing links in the arm formulas, from eight to forty, can or will be supplied. Any one studying these forms must become convinced that the arm formula, in all cases, in this genus, is of specific importance. After having examined many thousand specimens belonging to this genus, we are free to say, that in no case have we found two specimens having a different number of arms, that agreed in other characters, and hence the number of arms, as shown, in the calyx, before the arms became free, must rank in the first degree in determining the specific characters and in entitling the form to a specific name.

As no crinoidal species has ever been known to pass from the Kinderhook to the Burlington, or from the Burlington to the Keokuk, or from the Keokuk to the Warsaw or St. Louis, or from the St. Louis to the Kaskaskia, we have forty-three species above mentioned that may be distinguished by the number of arms alone.

We do not claim to have been original in laying stress upon the arm formula, in determiniing species, in this genus, for Prof. James Hall, in the contributions to the Palaeontology of Iowa, published in 1859, very properly defined the arm formula as of specific importance, in all the *Actinocrinidæ*, he described in that work.

The radial series furnished the characters for the determination of species no less important than the arm formula. In some species the first secondary radials are axillary, and in other species the second secondary radials are axillary. No two specimens possessing these characters can belong to the same species. It will be seen at once that the specimen having two secondary radials will have ten more radial plates within the calyx than the specimen having only one secondary radial, and a further examination will disclose the fact that the interradial areas are correspondingly different and the plates different in number or in size. The first tertiary radials may bear arms or they may be axillary, and the second tertiary radials may bear arms or they may be axillary, but no two specimens can belong to the same species, if they differ in these respects. That is, if one specimen has a single teritary radial and another has two teritary radials they cannot belong to the same species. And, again, while the number of arms in two species may be the same, yet the radial series will be entirely different; for example, one specimen may have three arms in each of four rays and four arms in the other making sixteen arms, and another may have three arms in each of two rays, and four arms in each of two rays, and two arms in the other, making sixteen arms. In such case the two specimens will belong to different species. It will be apparent that the changes, in the latter respect, may be very numerous in specimens having sixteen or more arms, and we find, in fact, that such is the case. It will be seen that these changes alone will provide for more species than have been described. These are therefore, fundamental variations. The general form, however, may be taken into consideration, and the regular and azygous areas dependent thereon as controlling the form, and also the surface ornamentation, especially where it includes the presence or absence of radial ridges, and these particulars may be of specific importance. But to place these species in a family distinct from the *Actinocrinidæ* is without any warrant so far as any learning has extended.

AGARICOCRINUS ADAMSENSIS, n. sp.

Plate I, Fig. 7, azygous side view; Fig. 8, summit view; Fig. 9, basal view.

Species medium or above medium size. Calyx nearly flat, though slightly convex about the basals and first radials. Outline subpentagonal. Plates thick, more or less convex, and part of them subspinous. Arm openings directed rather below a horizontal line.

Basals form an hexagonal disc, very little wider than the diameter of the column, that contains a hemispherical depresssion for the attachment of the column. Columnar canal quite small. The first primary radials are large, rather wider than long, three hexagonal and two heptagonal. All of them are sculptured so as to be pyramidal or subspinous, the apices extending below the basals, so that a specimen laid upon a table will rest upon these plates and the point of the first azygous plate. Second primary radials short, quadrangular, four or five times as wide as long. Third primary radials about one-half larger than the second, pentagonal, axillary, and in three of the rays support on each upper sloping side two secondary radials, which gives to each of these rays two arms. On the distal side of each third primary radial adjoining the azygous area, there are two secondary radials, and on the proximal side a single secondary radial, which is axillary and supports upon the distal superior sloping side a single tertiary radial, and on the proximal side two tertiary radials which gives to each of these rays three arms. There are, therefore, in this species twelve arms. The last tertiary and secondary radial in each series is thicker and more convex than the adjoining plates, and the ambulacral openings are in part exposed in a basal view.

In one of the regular interradial areas there are only two plates, in each of the other three regular interradial areas there are three plates. The first one rests between the superior sloping sides of the first primary radials and extends up between the first secondary radials. It is followed by one narrow elongated plate in one of the areas and by two narrow elongated plates in the other areas that connect with two plates belonging to the vault. The first azygous plate is in line with the first primary radials, about as large and heptagonal. It is followed by three plates in the second range, which are subequal in size, and each wider than long. In the third range there is a single plate that separates the tertiary radials and extends to the top of the calyx, where it is truncated the full width and unites with a single plate belonging to the vault.

The vault is moderately convex and is covered with large, convex, polygonal plates and a very large heptagonal central plate that supports a long, robust, conical spine. The spine commences to rise at the sutures of the seven adjoining plates. There is no indication of an azygous orifice, but the sutures between some of the plates on the azygous side of the central spine are obscure and possibly the orfice was covered with valvular plates, which have fallen back in place so as to absolutely close it without preserving the sutures. But in any event the orifice must have been very small.

This is a peculiar species, probably more nearly related to *A. hodgsoni* than to any other heretofore described. It does not need any comparison, however, with that species to distinguish it.

Found by C. S. Hodgson in the Burlington Group, in Adams county, Illinois, and now in the collection of S. A. Miller.

ACTINOCRINUS P~~A~~oLLUBRUM, n. sp.

Plate I, Fig. 25, basal view; *Fig. 26, summit view; Fig. 27, azygous side.*

Species medium size, somewhat lenticular, though the calyx is larger than the vault. Calyx basin-shaped, two and a half times as wide as high. No radial ridges. Plates thick, tumid and sculptured, so as to be more or less pyramidal. Ambulacral openings directed upward and not visible in a basal view.

Basals form an hexagonal disc with slight re-entering angles, having an hemispherical depression for the attachment of the column, and a diameter about one-half more than the diameter of the column. First primary radials rather larger than any other plates, in the body, three hexagonal and two heptagonal. Second primary radials about two-thirds as large as the first and hexagonal. Third primary radials about the size of the second, pentagonal, axillary, and support on each upper sloping side a single secondary radial, about the size of a third primary radial, which is axillary and bears upon each upper sloping side a single tertiary radial, which arrangement gives to this species twenty arms and twenty ambulacral openings to the vault.

All of the interradial and intersecondary radial areas connect with the vault. In the regular interradial areas there is one plate in the first range, two in the second, two in the third, and, in some of the areas, one in the fourth range that connects with the plates of the vault. In other cases there are two plates in the fourth range. There are, therefore, six plates in some of the regular areas, and seven plates in other areas. There is a single plate in each intersecondary radial area, and it connects with the plates of the vault. In the azygous area there are fifteen plates. The first plate is in line with the first primary radials, and nearly as large. It is followed by three plates in the second range and four plates in the third range, one of which extends as high as the top of the fourth range. In the fourth range there are two plates, and two in the fifth range, and two in the sixth range, both of which connect with the plates of the vault.

The vault is only moderately convex, and is covered with numerous small, polygonal plates. The smaller plates are convex and the larger ones subspinous.

The proboscis is small and central. No ovarian pores can be detected in our specimen, and hence it is probable that they opened through the first plates of the free arms.

This species is distinguished by its general form, peculiar vault, interradial, azygous and intersecondary areas. Though eighteen species have been heretofore described from the Burlington Group, bearing twenty arms, none of them have any near affinity with this species.

Found by F. A. Sampson, in the Burlington Group, at Sedalia, Missouri, and now in his collection.

AMPHORACRINUS SAMPSONI, n. sp.

Plate I, Fig. 28, azygous view; Fig. 29, opposite side.

Species varying from medium to large size. We have a specimen one-half larger than the one illustrated. Calyx bowl-shaped, subpentagonal, about as high as wide. Radial ridges distinct and subangular. Interradial areas very wide between the arms, where they unite with the plates of the vault. Plates depressed convex, but none of our specimens preserve the surface ornamentation, if it was ornamented. Column round and small.

Basals form a shallow hexagonal cup, about two and a half times as wide as the diameter of the column, and bearing a slightly concave depression for the attachment of the column. First primary radials are the largest plates in the calyx; they differ somewhat in size, and each one is about as long as wide, three hexagonal and two heptagonal. Second primay radials differ in size from about one-half to three-fourths as large as the first. They are hexagonal and nearly as long as wide. Third primary radials are much smaller than the second, pentagonal, axillary, and support on each superior sloping side two secondary radials, which arrangement gives to this species ten arms.

There are six regular interradials in each area. The first one is as large as a second primary radial. It is followed by two plates in the second range and three in the third, which unite with the plates of the vault. There is a small plate in each intersecondary radial area that unites with the plates of the vault. The plates in the azygous area are numerous, and are not disposed in ranges, but the plates on the sides are longer and larger than those more central. The first plate is in line with the first primary radials, though somewhat smaller. It is followed by three plates in the second range, the middle one being much the smallest. There are five plates in the third range, but the one on each side extends up two ranges higher than the three middle ones do, or there may be said to be as many as ten small plates over the central part of this area before they get as high as the two lateral plates in the third range. The azygous area is very wide in the superior part, and the small plates graduate into those of the vault so that no definite line can be drawn between them. As near as we can judge, however, there should be credited to the calyx, in this area, about forty plates. The two arms in each radial series are close together on each side of the azygous area, while the area is wide, somewhat bulged, and covered with small, irregularly disposed plates.

The vault is unknown. The species is far removed from all heretofore described.

Found by F. A. Sampson, in whose honor we have proposed the specific name, in the Chouteau limestone, at Sedalia, Missouri, and now in his collection.

FAMILY POTERIOCRINIDÆ.

BARYCRINUS NEGLECTUS, n. sp.

Plate II, Fig. 10, azygous view; Fig. 11, opposite view; Fig. 12, side view. Specimen slightly compressed.

Species medium size. Calyx obconoidal. Height nearly equal to the greater diameter. Surface granular. Deep, longitudinal depressions between the subradials, and round, deep pits at the angles between the subradials and radials. Column round.

Basals longer than wide and forming a cup more than one-third the length of the calyx. Subradials longer than wide, by reason of the longitudinal pits, they are contracted in the middle; four hexagonal and one heptagonal. First radials wider than long, deeply pitted at the inferior angles, and truncated about three-fourths of the width above for the first arm plates, or second radials, from which they are separated by a gaping suture. The second radials or first arm plates appear to be attached to the vault but they are followed by two rounded plates and these by an axillary plate. If these four plates are attached to the vault and the arms do not become free until they bifurcate, then this is a very remarkable species. The five radial series bifurcate on the fourth plate above the gaping suture and it is very clear that the arms are then free. Above this part our specimen does not preserve any characters.

The azygous area is also peculiar. The first plate is large and protuberant. It truncates a subradial broadly and slightly truncates another and reaches higher than the adjacent first radials, where it has two superior sloping sides and supports on each a series of rounded plates, that look externally like arm plates but of course they form part of the vault.

This species is distinguished by its form, radial system, and hexagonal first azygous plate. The calyx is like that of a *Poteriocrinus* and the pits and azygous area and plates link it with *Barycrinus*. It can not be mistaken for any other species

Found in the Keokuk Group, at Crawfordsville, Indiana, and now in the collection of Wm. F. E. Gurley.

POTERIOCRINUS ALBERSI, n. sp.

Plate II, Fig. 15, azygous side magnified two diameters; Fig. 16, opposite view, two diameters; Fig. 17, basal view. The specimen is slightly compressed.

Species small; plates covex, angular, rough. Calyx saucer-shaped, about two and a half times as wide as high; plates convex, surface granular.

Basals hidden, or nearly so, by the column. Subradials as long as wide and form with the basals a low cup. First radials one-half wider than long, pentagonal, highly convex toward the superior central part, truncated the entire width above and separated from the second radials by a gaping suture. Second radials about as long as wide, constricted and angular in the middle, axillary and support upon the upper sloping sides the free arms. The arms do not bifurcate. There are, therefore, ten arms in this species. The arms are long and composed of a single series of long cuneiform plates that alternately project for the support of coarse pinnules. The arms, therefore, have quite a rough aspect.

The azygous plates are alternately arranged. The first one is pentagonal, rests between the superior sides of two subradials and below the first radial on the right and abuts against the second and third plates. The second azygous plate truncates a subradial and abuts the first radial on the left and the first and third azygous plates on the right. The third azygous plate truncates an angle on the first plate and separates the first radial on the right from the second azygous plate. Above these the alternate arrangement is continued as far as the area is exposed in either of our specimens.

This species is distinguished by its saucer-shaped calyx, convex and tumid plates and ten rough arms composed of long cuneiform plates. It is one of the kind that has been referred to *Scaphiocrinus*, on account of the arm structure, but it does not agree with that genus, in the structure of the azygous area, but on the contrary is, in that respect, a *Poteriocrinus* to which genus we refer it. It will not be mistaken for any other species.

Found by the late Wm. McAdams, in the Kaskaskia Group, in Monroe county, Illinois, and now in the collection of Wm F. E. Gurley. The specific name is intended as a compliment to the artist and palæontologist who made the illustrations for this Bulletin.

POTERIOCRINUS LAUTUS, n. sp.

Plate II, Fig. 18, azygous side; Fig. 19, opposite view.

Species medium size. Plates angular, convex, rough. Calyx saucer-shaped, more than three times as wide as high. Surface granular.

Basals hidden or nearly so by the column. Subradials about as long as wide and forming a pentagonal disc very slightly saucer-shaped. First radials twice as wide as long, pentagonal, flattened centrally, truncated the entire width above and separated from the second radials or brachials by a gaping suture. Second radials wider than long, constricted in the middle and in four of the rays axillary, pentagonal and have steep upper sloping sides for the free arms. The arms are composed of cuneiform projecting plates. In the ray on the right of the azygous area the arms bifurcate on the fifth plate and the branch adjoining the azygous area does not bifurcate again, but the next one bifurcates on the ninth plate. The distal ray bifurcates on the seventh plate and the proximal one does not bifurcate. In other words, in this ray, one distal ray bifurcates and the other does not, and one proximal ray bifurcates and the other does not, which is an unusual method. In the other three lateral rays the arms bifurcate on the sixth plate and the distal arms bifurcate on the sixth, seventh and eighth plates and the proximal arms do not bifurcate. This arrangement gives to each of these four rays six arms. In the ray opposite the azygous area the only bifurcation takes place on the fifth plate, which gives to it two arms. There are, therefore, thirty-eight arms in this species.

The first azygous plate rests on the sloping side of a subradial and slightly truncates another below the first radial on the right, and abuts the second and third azygous plates. The second plate truncates a subradial and abuts the first radial on the left and extends above the gaping suture. The third plate truncates the first and extends nearly as high as the first arm plate. Above these the plates are alternate as far as disclosed.

This species is distinguished by its low calyx, thirty-eight arms and rough angular aspect. It is one of the kind that has been referred to *Scaphiocrinus* on account of the rough arms, but it does not agree with that genus, in the structure of the azygous area, but agrees with *Poteriocrinus*, to which genus we refer it. We think it is not a *Zeacrinus* with which it has some affinity. It cannot be mistaken for any other species.

Found in the Keokuk Group, at Boonville, Missouri, and now in the collection of F. A. Sampson.

POTERIOCRINUS NEGLECTUS, n. sp.

Plate IV, Fig. 3, side view, azygous area on the right; Fig. 4, side view, azygous area on the left: Fig. 5, azygous side; the specimen is laterally compressed, as shown by the illustrations.

Species medium or below medium size, constricted above the first radials. Calyx short, cup-shaped. Plates slightly convex; sutures distinct; surface granular. Column quite small.

Basals small but extending beyond the column and forming a low cup that is visible in a side view. Subradials rather large and about as wide as high. First radials a little wider than long, pentagonal, truncated the entire width above and separated from the second radials or brachials by a slightly gaping suture. A single, elongated brachial or second radial, rounded and contracted in the middle, and axillary, in four of the rays, supports upon its upper sloping sides the free arms. In the ray on the right of the azygous area the first brachial or second radial is a subquadrate plate that supports the second brachial or third radial, which is rounded, and axillary, and supports upon its upper sloping sides the free arms. The arms are long, slender, and fit compactly together and are composed of a single series of cuneiform plates. The arms do not bifurcate and there are, therefore, only ten arms in this species. Pinnules are not large and are arranged on the inner part of the arms so as not to prevent the arms from fitting compactly together.

The azygous plates alternate, as is usual in this genus The first plate is the largest, which is an unusual feature, and rests upon the upper sloping sides of two subradials, separates the first radial on the right from the second azygous plate and is truncated above by the third azygous plate. The second plate is somewhat smaller than the first, hexagonal and only slightly truncates a subradial. It abuts upon the first radial and part of the second radial or brachial on the left. Above it the plates alternate and become rapidly smaller.

This species is distinguished by its general form, slender arms, and by having a single brachial in four of the rays and two brachials in the ray on the right of the azygous area. This last feature shows that *Poteriocrinus* cannot be divided into subgenera based on the presence of one or two brachials in the rays.

Found in the Keokuk Group, at Boonville, Missouri, and now in the collection of Wm. F. E. Gurley.

POTERIOCRINUS ARRECTARIUS, n. sp.

Plate IV, Fig. 6, azygous side view, showing part of the proboscis.

Species medium size and not constricted above the calyx. Calyx obconoidal. Sutures distinct. Surface smooth or finely granular.

Basals partly broken away from our specimen, but enough is preserved to show that they form an obconoidal cup. Subradials large and longer than wide. First radials nearly as long as wide, pentagonal, truncated the entire width above, and separated from the second radials or first brachials by a very slightly gaping suture. Second radials or first brachials subquadrate, as long as wide and slightly constricted in the middle. Third radials or second brachials a little shorter than the first, very slightly constricted in the middle, axillary, and support upon the upper sloping sides the free arms. The arms do not bifurcate and there are, therefore, ten arms in this species. The arms are long, slender, and composed of a single series of cuneiform plates that bear small pinnules. The pinnules are from the inside of the arms so as to allow the arms to come together.

The azygous plates alternate, as is usual in this genus. The first plate is the largest and rests upon the upper sloping sides of two subradials, separates the first radial on the right from the second azygous plate and is truncated on top by the third azygous plate. The second plate is somewhat smaller than the first, hexagonal, and only slightly truncates a subradial. The azygous area above these plates is wide and terminates in a wide and long proboscis that, in our specimen, extends beyond the parts of the arms which are preserved and appears to have extended beyond the tips of the arms. The proboscis is fluted and punctured with longitudinal rows of pores between the longitudinal series of plates of which it is composed.

This species is distinguished by its general form, structure of the arms and character of the proboscis.

Found by the late Wm. McAdams in the St. Louis Group, at Alton, Illinois, and now in the collection of Wm. F. E. Gurley.

POTERIOCRINUS LABYRINTHICUS, S. A. Miller.

Plate IV, Fig. 7, azygous view.

[*Cyathocrinus labyrinthicus*, S. A. Miller, 1891. Advance sheets of the 17th report of the Geology and Natural History of Indiana, page 48, and final report, page 659, plate XII, figs. 11 to 14.]

Though several specimens of this species had been collected at the time it was described, none of them fully exposed the azygous area. They showed the azygous plate truncating a large subradial but the folding of the arms around the calyx happened to cover the first azygous plate, which rests between the superior sloping sides of two subradials, and separates the first radial on the right from the second azygous plate and is truncated above by the third azygous plate, which shows that it is a *Poteriocrinus.* The second plate is large and broadly truncates a subradial and was supposed at the time of the description of the species to be the first azygous plate which caused the species to be erroneously referred to *Cyathocrinus.* The position of the first and second azygous plates and the alternate arrangement of the succeeding plates show very clearly that it is a *Poteriocrinus.* Several specimens showing this fact are in the collection of S. A. Miller, but received by him after the species had been described and illustrated. The specimen now illustrated is from the same exposure of the Keokuk Group, at Boonville, Missouri, and is now in the collection of Wm. F. E. Gurley.

SCAPHIOCRINUS NOTATUS, n. sp.

Plate II, Fig. 25, azygous view; Fig. 26, opposite side of same specimen, which is slightly compressed.

The specimen illustrated is compressed so as to appear about one-fifth wider than it really is. The species is above medium size. Calyx short, about twice as wide as high, depressed angular between the first and second radials, so as to give a pentagonal outline.

Column small, round, although broken away from the specimen figured and the small basal plates have been carried away with it, as the angles between the plates shown in fig. 25 indicate. Subradials evidently larger than the basals, four hexagonal and one heptagonal. The lateral sides gradually expand. First radials nearly twice as large as the subradials, about twice as wide as high, pentagonal, truncated the entire width above, convex toward the superior central part, and separated externally from the second radials by a gaping suture. Second radials larger than the first, twice or more than twice as wide as high, longitudinally angular in the central part, pentagonal, and in three of the rays support upon each upper sloping side a robust arm. In the ray adjoining the azygous area, on the right, the distal side of the second radial bears a single arm and the proximal side bears a secondary radial, which is axillary, and supports upon each upper sloping side a free arm; and the ray adjoining the azygous area on the left, bears, on the proximal side of the second radial, a single arm, and on the distal side a secondary radial that is axillary, and supports an arm on each upper sloping side, which arrangement gives to each of these rays three arms. There are, therefore, twelve arms in this species

The arms are robust, and in the lower part composed of quadrangular plates with transverse sutures, which graduate into cuneiform plates in the upward extension of the arms. Each plate supports upon the thicker end a coarse, strong pinnule, and in the middle part a small node, which form a row of nodes on each arm, that gives it a somewhat rough aspect.

There is only one azygous plate. It truncates the larger subradial, separates the first radials but does not extend as high as the second radials, which unite over the top of it. The single azygous plate is, therefore, enclosed within the side of the calyx in the same manner that it is in *Graphiocrinus.*

If this species had no subradials, we would refer it to *Graphiocrinus,* notwithstanding it has twelve arms; but as no species having subradials can be congeneric with one not having them, we have no hesitation in saying, that it is not a *Graphiocrinus.* And here we may say, that after having examined definitions and illustrations of all the species found in this country, that have been referred to *Graphiocrinus,* by different authors, we are fully convinced that the genus has not been found in America.

When Prof. James Hall founded the genus *Scaphiocrinus,* in the Geology of Iowa, Vol. I, p. 551, and described the type, *Scaphiocrinus simplex,* he very clearly distinguished it from

Graphiocrinus. The species here described is distinguished from *Scaphiocrinus simplex*, by having twelve arms instead of ten, which is a good specific distinction but not of generic importance. It is distinguished again from *S. simplex*, which has six azygous plates or more, that rise above the calyx, by having only one azygous plate confined between the plates of the calyx. This may be of generic importance, but we are not willing to found a new genus upon differences of doubtful importance, when they are known to belong to only a single species. In each case the first azygous plate truncates a subradial and the difference consists, in the additional plates, that separate the second radials and first arm plates, in one species, that do not exist in the other. We prefer, at present, to regard this as of specific importance only. The distinction made by Prof. Hall between *Scaphiocrinus* and *Poteriocrinus* is a good one and all the species he referred to *Scaphiocrinus* properly belong there, as well as some that others have defined. None of them belong to *Graphiocrinus.*

Found in the Kinderhook Group, at LeGrand, Iowa, and now in the collection of Wm. F. E. Gurley.

FAMILY AGASSIZOCRINIDÆ.

AGASSIZOCRINUS OVALIS, n. sp.

Plate II, Fig. 13, an entire specimen viewed opposite to azygous area; Fig. 14, azygous side, of another calyx.

Species large, contracted at the top of the calyx. Calyx somewhat obovoid; surface smooth; sutures distinct. No evidence of a column. Height and greatest diameter subequal.

Basal plates small and forming a low cup with a subacute point below and having upper sutures slightly concave for the reception of the subradials. Subradials longer than wide, showing expanding to the superior lateral angles, and each of them gently rounded. First radials pentagonal, about one-half wider than high, and curving inward, so that the greatest diameter of the calyx is but little above the inferior angle. They are truncated the entire width above and separated from each second radial by a gaping suture. Second radials smaller than the first, curve gently inward and are slightly contracted on the sides. Each one is axillary and supports on each upper sloping side a free arm giving to the species ten arms. The arms are long subfusiform, and composed of a single series of short plates with transverse sutures above the first plate.

Azygous plates three. The first one is subquadrate, except being slightly truncated at one angle by the third plate, it, therefore, has five sides. It is not as large as a first radial and rests between the superior sides of two subradials and below the first radial on the right and supports on its two upper sides the second and third azygous plates. The second azygous plate is smaller than the first, truncates a subradial and abuts a first radial on the left. The third azygous plate is smaller than the second, truncates the first and separates the second from the first radial on the right.

This species is distinguished by its general form, small basals and azygous plates.

Found by the late Wm. McAdams, in the Kaskaskia Group, Randolph county, Illinois, and now in the collection of Wm. F. E. Gurley.

FAMILY RHODOCRINIDÆ.

RHODOCRINUS BLAIRI, n. sp.

Plate II, Fig. 20, basal view; Fig. 21, azygous side; Fig. 22, opposite side; Fig. 23, summit view. Each of these views is magnified two diameters, and they are all taken from the same specimen.

Species small, much below medium size. Calyx bowl-shaped, subpentagonal in transverse section; radial ridges moderately well defined; plates convex. Basal cavity very deep. Column small, canal minute.

Basals form a cone within the calyx, into which the end of the column is inserted. Subradials the largest plates in the body, very convex, as long as wide, one octagonal, the others heptagonal. They are abruptly bent and rounded in the middle, the lower part forming part of the funnel-shaped columnar cavity and the upper part curving as abruptly upward. First primary radials about half or two-thirds as large as the subradials, two hexagonal and three heptagonal. Second primary radials less than one-fourth as large as the first, a little wider than long, quadrangular. Third primary radials about the size of the second, pentagonal, axillary, and support upon each upper sloping side a single secondary radial, which gives to the species ten ambulacral openings to the vault.

The first interradial truncates a subradial in the azygous area, and in three of the regular interradial areas in the other interradial area two plates truncate a subradial, which makes it octagonal, as above stated. The first plate in the azygous area is, however, larger than the first plate in either of the regular areas. In three of the regular interradial areas there are two plates in the second range, and in the other area there are three, and in the third range three plates in two of the areas and two in each of the other two areas. The plates in each of these areas graduate into the plates of the vault, so there is no distinct line of separation between the plates of the calyx and those of the vault. In the azygous area there are three plates in the second range, the middle one of which abuts upon the azygous orifice, which is placed midway between the ambulacral openings at the top of the calyx, where it is surrounded by seven plates.

The vault is slightly convex toward the center and correspondingly depressed in the interradial areas at the margin. It is covered by numerous small, polygonal, convex plates.

This is a very strongly marked species and it is wholly unnecessary to compare it with any other, though it is very clearly a ***Rhodocrinus.***

Found by R. A. Blair, in whose honor we have proposed the specific name, in the Chouteau limestone, at Sedalia, Missouri, and now in the collection of S. A. Miller.

FAMILY CYATHOCRINIDÆ.

CYATHOCRINUS CHOUTEAUENSIS, Miller and Gurley.

Plate II, Fig. 24, view opposite the azygous area of a small specimen magnified two diameters.

[***Cyathocrinus chouteauensis,*** Miller and Gurley, Bull. No. 7 of Ill St. Mus. p. 68, pl. IV, fig 16, Dec. 5, 1895.]

We have a specimen that we suppose belongs to this species, but it is only about one-fourth as large as the type, and we have illustrated it, because it has a pentagonal column and the column was not preserved in the type. It will be observed that it is magnified two diameters, without being as large as the type, which was illustrated natural size. The arms appear to have been composed of longer plates than those belonging to the type and some other minor differences may be observed, but there is such a striking resemblance between the two, that we think they belong to the same species. If correct the species was quite variable, in size, and possessed a small pentagonal column.

Found by R. A. Blair in the Chouteau limestone, at Sedalia, Missouri, and now in the collection of S. A. Miller.

CYATHOCRINUS BLAIRI, Miller and Gurley.

This species was described and illustrated in Bulletin No. 7 of the Ill. St. Mus. p. 67, pl. IV. figs. 11 to 15, and in Bulletin No. 8 p. 50, pl. III, figs. 21 and 22. Some doubt was expressed as to the generic reference, and, probably, we should have compared it, in the bulletin last mentioned, with *Mespilocrinus* of De Koninck and LeHon. But *Mespilocrinus* as defined and illustrated has only three basal plates and *Cyathocrinus blairi* has five, which must separate them generically. Above the basal plates *Cyathocrinus blairi* substantially agrees with *Mespilocrinus*, and, if it possessed only three basal plates, we would refer it to *Mespilocrinus*. The general accuracy of De Koninck, in scientific matters, and the fact that we have never found him inaccurate in stating the structure of a crinoid, leaves no doubt in our minds that *Mespilocrinus* has only three basal plates. Two species of *Mespilocrinus* have been described, from the Burlington Group of this country, by Prof. James Hall. They are distinct species and are undoubted *Mespilocrinus*, if he was not mistaken in the number of basal plates, which we have no right to assume. Possibly, the small specimen figured, in Bulletin No. 7, may be distinct from the type of *Cyathocrinus blairi* and if so a new genus may very well be founded for their reception, but the genus would belong to the family *Cyathocrinidæ* and not to the *Ichthyocrinidæ*, where we refer *Lecanocrinus* and *Mespilocrinus*.

FAMILY DOLATOCRINIDÆ.

DOLATOCRINUS DISPAR, n. sp.

Plate II, Fig. 27, side view; Fig. 28, basal view; Fig. 29, summit view.

Species below medium size. Calyx low, somewhat bowl-shaped, gradually expanding from a truncated base to the free arms, without constriction. Radial ridges sharply angular and bear a sharp node, at the middle of each plate. There is also a sharp node on each interradial and a few obscure radiating lines. The primary radials bear no radiating lines. Column round and contains a large cinque foil canal.

Basal disc pentagonal, one fourth wider that the diameter of the column, and contains the concavity into which the end of the column is inserted. First primary radials nearly as long as wide and each one bears a long central node, on the points of which the calyx will rest. Second primary radials wider than long, quadrangular. Third primary radials smaller than the second, pentagonal, axillary, and, in the ray on the right of the azygous area, support on the distal side two secondary radials and on the proximal side a single secondary radial, that is axillary, and supports on each upper side a single tertiary radial, and, in the ray on the left of the azygous area, supports on the proximal side two secondary radials and on the distal side a single secondary radial that is axillary, and supports upon each upper side a single tertiary radial, which gives to each of these rays three arms. In each lateral ray, the third primary radial supports on each upper side a single secondary radial, which is axillary and supports on each upper side a tertiary radial which arrangement gives to each of these two rays four arms. In the ray opposite the azygous area the third primary radial bears upon each upper side two secondary radials which gives to this ray two arms. There are, therefore, sixteen arms in this species. The arm formula is 3+4+2+4+3.

The azygous area is substantially like the other areas. The first interradials are the largest plates in the calyx, have eleven sides, and are followed by three plates in the second range that unite with the plates of the vault.

The vault is only moderately elevated, but the radial ridges are sharply elevated over the ambulacral canals. The azygous orifice is at the top of a central, short elevation. The plates bear small nodes. The sutures between the plates are not distinct in our specimen, and for that reason are not shown in the illustrations. Ovarian apertures small and at the base of the free arms. One on each side of each pair of arms or sixteen in all.

This species is distinguished from all other sixteen-armed species by its general form and surface ornamentation, and also by the plates in the interradial areas, and by the arm formula.

Found by J. F. Hammell in the Hamilton Group, near Charlestown, Indiana, and now in the collection of Wm. F. E. Gurley.

DOLATOCRINUS PRECIOSUS, n. sp.

Plate II, Fig. 30, basal view; Fig. 31, summit view; Fig. 32, view opposite azygous area.

Species above medium size and very handsomely ornamented. Calyx broadly truncated at the base, and constricted below the arms. Radial ridges delicate, with sharp elongated nodes at the central part of the plates. Surface marked by radiating lines of sharp nodes, which are longitudinal, in the upper part of the interradial areas. In some cases the nodes coalesce so as to form lines. The column is round and medium size.

Basal plates form a hollow cone within the cavity of the calyx, which is filled with the end of the column so as to leave a pentagonal disc, at the surface, only a little wider than the diameter of the column. First primary radials nearly as long as wide and subequal in size. Second primary radials large, quadrangular, and about as long as wide. Third primary radials expand to the superior lateral angles. They are larger than the second, pentagonal, axillary, and in the ray on the right of the azygous area and in the left lateral ray, as seen by looking at the vault, bear upon each upper sloping side a single secondary radial, which is axillary and bears upon each upper side two tertiary radials, which gives to each of these rays four arms. In the ray on the left of the azygous area, and in the right lateral ray, the third primary radials bear upon each superior sloping side three secondary radials, which gives to each of these rays two arms. In the ray opposite the azygous area the third primary radial bears upon one upper sloping side a single secondary radial, which is axillary, and supports upon each upper side two tertiary radials, and upon the other three secondary radials, which gives to this ray two arms. There are, therefore, fifteen arms in this species.

The azygous area is very much like the other interradial areas. The first interradials are large and have nine sides and are truncated above by the second interradials. The second interradials are about one-third as large as the first, and are followed in the third range by a somewhat smaller plate that unites with two elongated plates belonging to the vault.

The vault is slightly convex, and correspondingly depressed in the interradial areas toward the margin. It is covered by two circles of plates and a few intercalated ones, the surface of which is beautifully ornamented with coarse granules and delicate nodes. It bears a subcentral azygous orifice slightly elevated above the rest of the vault, and which appears to be about complete in the specimen illustrated. There are small ovarian apertures passing through the plates forming part of the covering of the ambulacral canals near the base of the arms. One on each side of each pair of arms and one on each side of the single arm, which gives to this species sixteen ovarian apertures.

This species most resembles *D. charlestownensis*. In that species the arm formula is 3+4+3+2+3, while in this species it is 4+2+3+4+2. The arms are so arranged in that species that the ray on each side of the azygous area has three arms, while in this, one has two arms and the other four. The proportional size of the plates and the surface ornamentation also differ and there are other minor differences. The arm formulas, however, are sufficient to readily distinguish the species at all times, and such differences are always of specific importance.

Found by Geo. K. Greene in the Hamilton Group, near Charlestown, Indiana, and now in the collection of Wm. F. E. Gurley.

DOLATOCRINUS BASILICUS, n. sp

Plate III. Fig. 1, basal view; Fig. 2, summit view; Fig. 3, side view.

Species large and very much like *Dolatocrinus indianensis*. Calyx subcylindrical, very broadly truncated, and constricted below the ambulacral openings. Radial ridges small, angular, central nodes elongated Radiating lines from the central part of each plate numerous. Column round and having a large cinque foil columnar canal.

Basal plates form a pentagonal disc about one-third wider than the diameter of the column and having an hemispherical depression for the attachment of the column. First primary radials from one-third to one half wider than long and subequal in size. Second primary radials about one-half wider than long, quadrangular. Third primary radials expand slightly to the superior lateral angles. They are from one-half wider to twice as wide as long, pentagonal, axillary, and, in the rays on each side of the azygous area and in the ray opposite the azygous area bear upon each superior sloping side a single secondary radial, which is axillary and bears upon each upper sloping side two tertiary radials, which gives to each of these rays four arms. In one of the lateral rays the third primary radial bears upon one superior sloping side three secondary radials, and upon the other a single secondary radial, which is axillary and bears upon each upper sloping side two tertiary radials. This ray, therefore, has three arms. In the other lateral ray the third primary radial bears upon each upper sloping side three secondary radials, that give to it two arms. There are, therefore, in this species, seventeen arms and seventeen ambulacral openings to the vault, all of which are directed upward.

The azygous area is substantially like the other areas. The first interradials are the largest plates in the calyx, have nine sides and are broadly truncated above for the second interradials. The second interradials are about half as large as the first, though somewhat unequal in size. The third interradials are less than half as large as the second, and are followed, in one of the areas, by two plates, in the fourth range, that unite with two elongated plates belonging to the vault, and in each of the other areas by a single plate, in the fourth range, that unites with two elongated plates belonging to the vault.

The vault is moderately convex, and covered with a few large polygonal plates. The azygous orifice is subcentral and slightly elevated above the surrounding convexity of the vault, as shown in the illustrations. The specimen is complete, except there may have been small plates that covered the orifice itself. The plates covering the vault are coarsely granular, and those over the junction of the ambulacral canals bear small nodes. There are two elongated plates in each interradial area, and, within these, a circle of seven plates surrounds the base of the elevation for the azygous orifice. There are twenty ovarian pores situated close to the ambulacral openings; one on each side of the double arm openings and one on each side of the single arm openings.

This species is distinguished from *Dolatocrinus indianensis*, which it most resembles, by having one more range of interradial plates in each area, and one more plate in each tertiary radial series, and one more plate in each three secondary radial series. This arrangement lengthens the calyx correspondingly and adds to the radials in the calyx seventeen plates, and to the interradials six plates, as the fourth range, in one of the areas, contains two plates. Other differences in the two species seem to us to be of minor importance, but these, taken together, are of specific value, as we understand the structure of crinoids, in this genus.

Found by Geo. K. Greene, in the Hamilton Group, near Charlestown, Indiana, and now in the collection of Wm. F. E. Gurley.

DOLATOCRINUS LYONI, n. sp.

Plate III, Fig. 4, summit view; Fig. 5, basal view; Fig. 6 azygous side view.

Species medium size. Calyx subhemispherical, broadly truncated and slightly constricted below the arms. Radial ridges small, angular nodes at the center of each plate, sharp and elongated. Surface of each plate ornamented with numerous fine lines radiating from a sharp central node. Column medium size, round and having a very large cinquefoil canal.

Basals form a pentagonal disc, full one-half wider than the diameter of the column, and having an hemispherical depression, for the attachment of the colomn, surrounded by a small rounded rim. First primary radials nearly as long as wide and subequal in size. Second primary radials rather large, quadrangular, and nearly as long as wide. Third primary radials very little, if any, larger than the second, wider than long, pentagonal, axillary and in two of the lateral rays bear upon each upper sloping side three secondary radials which gives to each of these rays two arms. In the ray on each side of the azygous area and in the ray opposite thereto, the third primary radial supports, upon one upper sloping side three secondary radials, and upon the other a single secondary radial that is axillary and supports upon each upper sloping side two tertiary radials, which arrangement gives to each of these rays three arms. There are, therefore, thirteen arms, in this species. In the ray on the left of the azygous area, it is the proximal side of the third primary radial, that bears the three secondary radials, and in the ray on the right it is the distal side that bears the three secondary radials.

The azygous area is substantially like the other interradial areas. The first interradials are the largest plates in the calyx, have nine sides, and are broadly truncated above for the second interradials. The second interradials are about or more than half as large as the first, and are followed by a single plate in the third range full half as large as the second, which unites with two elongated plates belonging to the vault.

The vault is moderately convex, and correspondingly depressed in the interradial areas toward the margin. It is covered with a few rather large plates but the sutures are too indistinct in our specimens for illustration. The plates are granular but most of the granules are eroded, on our specimens, so they are not shown in the illustration. Each plate over the junction of the ambulacral canals bears a strong central node. The azygous orifice is nearly central on the vault and elevated but little above it. There is an ovarian aperture on each side of each pair of arms and on each side of each single arm close to the ambulacral openings which gives to this species sixteen ovarian apertures.

This is the first species of *Dolatocrinus* that has been described having thirteen arm openings to the vault and hence the arm formula alone will distinguish it from all other species.

The specific name is in honor of the late Sydney S. Lyon, who established the genus. Found by Geo. K. Greene, in the Hamilton Group, near Charlestown, Indiana, and now in the collection of Wm. F. E. Gurley.

DOLATOCRINUS CISTULA, n. sp.

Plate III, Fig. 7, basal view; Fig. 8, summit view; Fig. 9, side view.

Species medium size and handsomely sculptured. Calyx subhemispherical, slightly constricted below the arms and broadly truncated at the base. Radial ridges rather large and bearing sharp, elongated nodes. Surface of all the plates bear more or less elongated nodes, and there are a few radiating lines on the first interradials Column round and having a large cinque foil canal.

Basal plates form a pentagon one fourth wider than the diameter of the column, having an hemispherical depression or cavity for the insertion of the end of the column. First primary radials wider than long, and subequal in size. Second primary radials large, quadrangular and nearly as long as wide. Third primary radials rather larger than the second, pentagonal, axillary, and, in the ray on the right of the azygous area and in the left lateral ray, support on each upper sloping side a single secondary radial, which is axillary and bears upon each upper side two tertiary radials, which gives to each of these rays four arms. In the ray on the left of the azygous area and in the one on the right lateral side the third primary radials support on one upper sloping side three secondary radials, and on the other a single secondary radial that is axillary and bears upon each upper side two tertiary radials, which gives to each of these rays three arms. It is the proximal ray adjoining the azygous area that bears the tertiary radials. In the ray opposite the azygous area the third primary radial supports upon each upper sloping side three secondary radials, which gives to this ray two arms. There are, therefore, sixteen arms in this species. The arm formula is 4+3+2+4+3.

The azygous area is substantially like the others. The first interradials are the largest plates in the calyx, have nine sides and are broadly truncated for the second interradials. The second interradials are more than half as large as the first, and are followed by three plates in the third range, the middle one only abutting upon the third ones, while the lateral ones form part of the covering for the ambulacral channels. The third range unites with two elongated plates belonging to the vault.

The vault is only slightly convex, and is covered with a few large nodose plates. The azygous orifice is at the summit of a short elevation, at the central part of the vault. There are twenty small ovarian apertures.

This species is distinguished from all other sixteen-armed species by its general form and surface ornamentation, and also from all of them by the arm formula. For example, the arm formula in *D. cœlatus* is 4+4+4+2+2, in *D. nodosus* it is 4+3+3+3+3, in *D. salebrosus* it is 4+3+2+3+4, in *D. hammelli* it is 4+3+3+3+3, and in *D. arrosus* it is 4+4+3+3+2.

Found by Geo. K. Greene in the Hamilton Group, near Charlestown, Ind., and now in the collection of Wm. F. E. Gurley.

DOLATOCRINUS ASPER, n. sp.

Plate III; Fig. 10, basal view; Fig. 11, summit view; Fig. 12, azygus side view.

Species medium or rather below medium size. Calyx subhemispherical, broadly truncated, and constricted below the arms. Radial ridges small, sharply angular, and bear a longitudinal sharp node at the middle of each plate. Ridges radiate from a node at the center of each plate. Column round and bears a cinquefoil central canal.

Basal plates form a hollow cone within the cavity of the calyx. The column fills the cone so that the diameter of the column is nearly equal to the diameter of the pentagonal basal disc. First primary radials nearly or quite as long as wide and subequal in size. Second primary radials quadrangular and nearly as long as wide. Third primary radials expand very slightly and are about the size of the second primary radials. They are pentagonal, axillary, and the ray opposite the azygous area bears upon each upper sloping side a single secondary radial which is axillary and bears upon each upper side two tertiary radials which gives to this ray four arms. In one of the lateral rays the third primary radial supports on each upper sloping side two secondary radials which gives to it only two arms. In the rays on each side of the azygous area and in one of the lateral rays the third primary radial supports upon one of its superior lateral sides three secondary radials and upon the other a single secondary radial, which is axillary and supports upon each upper sloping side two tertiary radials, which arrangement gives to each of these three rays three arms. There are, therefore, fifteen arms in this species. In the rays adjoining the azygous area the proximal sides of the the third primary radials support the three secondary plates and each distal side supports the single secondary radial that bears the tertiary series. The arms are composed of a single series of rounded cuneriform plates.

The interradial areas are substantially alike and the azygous area can hardly be distinguished from them. The first interradials are the largest plates in the calyx and have nine sides. They are broadly truncated for the second interradials. The second interradials are not half as large as the first, and each one is followed by a much smaller plate in the third range that united with two plates belonging to the vault.

The vault is quite convex, sharply elevated over the ambulacral canals, and deeply depressed in the interambulacral areas toward the margin. The sutures are partly destroyed in our specimens, so the plates cannot be distinguished, and the surface is more or less eroded and hence these features are not shown in the illustrations. Each plate over the junction of the ambulacral canals bears a strong sharp node. The azygous orifice is somewhat elevated over the central part of the vault. There is a small ovarian aperture close to the ambulacral orifice on each side of each pair of arms and on each side of each single arm, which gives to the species eighteen ovarian apertures.

This species is most nearly related to *Dolatocrinus charlestownensis*, with which it agrees in having fifteen arms. But the arms are not distributed in the same way. In this species the four-armed ray is opposite the azygous area, in that species a three-armed ray is opposite the azygous area and the four-armed ray is lateral. In this species the secondary series and single arm adjoins the azygous area on each side, in that species the secondary series and single arm adjoins the azygous area upon one side and the tertiary radials and double arm on the other. These structural differences must separate the species, though the vaults are also quite different in form and do not agree in the number of the plates, and the surface markings are not the same.

Found by Geo. K. Greene, in the Hamilton Group, near Charlestown, Indiana, and now in the collection of Wm. F. E. Gurley.

DOLATOCRINUS APLATUS, Miller and Gurley.

[*Dolatocrinus aplatus*, Miller and Gurley, Bull. No. 8 Ill. St. Mus. Nat. Hist., p. 48.]

Plate 3, Fig. 13, basal view; Fig. 14, summit view; Fig. 15, side view.

We have illustrated another specimen belonging to this species for the purpose of showing the plates of the vault which are well preserved and the sutures distinct. There are slight differences in the surface ornamentation in the different specimens, but the structural parts of four specimens which we have now before us are the same. All of them are in the collection of Wm. F. E. Gurley.

DOLATOCRINUS ASPRATILIS, n. sp

Plate 3, Fig. 16, basal view; Fig. 17, summit view; Fig. 18 azygous side view

Species rather below medium size. Calyx pentagonal from base to arms, somewhat bowl-shaped, broadly truncated, most expanded in the middle, and constricted below the arms. Columnar cavity pentagonal and deep. Radial ridges angular with long central nodes. Plates pyramidal and radiately sculptured

Basal concavity pentagonal, funnel shaped, and without ornamentation. Basal plates form a hollow cone within the calyx, into which the end of the column is inserted. First primary radials as long as wide and abruptly bent in the middle, the lower part forming part of the funnel-shaped columnar cavity, and the superior end curving as abruptly upward. The plates are pyramidal, with the apex at the center, and radiately sculptured. A furrowed ridge extends from the apex of one plate to the next, which forms the pentagonal outline of the basal concavity and on which the calyx will rest if placed on a level surface. Second primary radials quadrangular, about one-fourth wider than long and sides nearly parallel. Third primary radials smaller than the second, one-half wider than long, pentagonal, axillary, and in four of the rays support on each upper sloping side two secondary radials, which gives to each of these rays two arms. In the ray adjoining the azygous area on the right the third primary radial supports on the proximal side three secondary radials, and on the distal side of a secondary radial that is axillary and supports upon each upper sloping side two tertiary radials which gives to this ray three arms. There are, therefore, eleven arms in this species. The arms are composed, at the base, of a single series of plates.

In the regular interradial areas there are only two plates, but the azygous area is wider in the superior part and contains three plates. The first interradials are large, pyramidal and radiately sculptured. The second plate is quite small, not more than one fourth as large as the first and it connects with two plates belonging to the vault. The first azygous plate is like a regular first interradial and is followed by two plates in the second range that unite with three plates belonging to the vault.

The vault is sharply elevated over the ambulacral canals and deeply depressed in the interambulacral areas. The azygous orifice is elevated at the central or subcentral part of the vault, but can hardly be said to be at the summit of a proboscis. The vault is covered with polygonal plates, which, in our specimens, show no surface ornamentation. The ovarian pores appear to be within the last plates belonging to the calyx, and, therefore, to have opened externally at the first free arm plates. There are probably twelve of them, but only part can be seen in our specimens.

There can be very little utility in comparing this species with *D. approximatus*, the only species heretofore described, having eleven arms, for that species has an elongated calyx, four secondary radials in each series, and four ranges of plates in the interradial areas, with four ovarian pores entering the vault between each of the rays, that are continued in furrows across the last interradial plates. It can be of no service to compare it with any species having a different arm formula, for that alone distinguishes it Probably it most resembles *D. bulbaceus* which has only ten arms.

Found by Geo. K. Greene in the Hamilton Group, near Charlestown, Indiana, and now in the collection of Wm. F. E. Gurley.

DOLATOCRINUS LAGUNCULA, n. sp.

Plate III, Fig. 19, basal view; Fig. 20, side view; Fig. 21, summit view.

This species is founded upon five specimens, a medium one being illustrated, and the largest having a diameter one-fourth greater. Calyx low, expanded at the arms, from three to three and a half times as wide as high and deeply and broadly concave below. Columnar pit funnel-shaped and having within it near the top two pentagonal raised ridges running from a tubercle in the middle of each first radial to the next adjoining. Radial ridges merely sharp elevations crossing the plates and interrupted by sharp nodes at the center of each plate. Surface radiately sculptured. Column round, inserted into the cup formed by the basal plates and having a cinquefoil columnar canal.

Basal plates form a round cup so deeply inserted in the calyx that it rises higher than the calyx and ends in the cavity of the vault. The mouth of the cup is about one-third wider than the diameter of the column. First primary radials about as wide as high, sculptured in the upper part. Second primary radials quadrangular, and about twice as wide as high. Third primary radials expand upward to the lateral angles, longer than the second, pentagonal, axillary and in each of four rays bears upon one upper sloping side four secondary radials and upon the other one secondary radial, which is axillary and bears upon each upper sloping side three tertiary radials, which arrangement gives to each of these rays three arms. In the other ray the third primary radial supports upon each upper sloping side four secondary radials which gives to it two arms. There are therefore, fourteen ambulacral openings to the vault and fourteen arms in this species.

The first regular interradials are nine-sided plates followed in the second range by a smaller plate which in turn is followed by two small plates that unite with the plates of the vault. The azygous area is not materially different from the other areas.

The vault is convex, most tumid on the azygous side, and bears a subcentral proboscis which is longer on one of the specimens than it is on the specimen illustrated. The plates are large and those about the base of the proboscis bear a central tubercle. There are four elongated ovarian apertures between each radial series and between each single ray and the double ray in each series and two between the other rays which gives to the species forty-eight of these apertures.

The surface ornamentation and general form of this species resembles *D. hammelli*, but that species has sixteen arm openings to the vault while this one has only fourteen. which will readily distinguish the species.

Found by J. F. Hammell in the Hamilton Group near Charlestown, Indiana, and now in the collection of Wm. F. E. Gurley.

DOLATOCRINUS ARROSUS, n. sp.

Plate III, Fig. 22, basal view; Fig 23, azygous side; Fig. 24, summit view.

Species medium size and elegantly sculptured. Calyx sub cylindrical, not constricted below the arms, broadly truncated at the base. Radial ridges rather large and bearing prominent nodes in the middle part of each plate. The surface is further ornamented by long sharp nodes at the center of the interradials and by numerous radiating lines from the central nodes of all the plates. Column large and having a large cinquefoil canal.

Basal plates form a pentagon less than one-fourth wider than the diameter of the column and having an hemispherical depression for the insertion of the end of the column. First primary radial a little wider than long, subequal in size, and the calyx will rest on the points of the central nodes in these plates. Second primary radials large, very little wider than long, quadrangular. Third primary radials about the size of the second, pentagonal, axillary, and in two of the rays support on each upper sloping side a single secondary radial which is axillary and supports on each upper sloping side two tertiary radials which gives to each of these rays four arms. These two rays adjoin the azygous area. In each of the lateral rays the third primary radial supports on one upper sloping side three secondary radials, and on the other a single secondary radial which is axillary and supports upon each upper sloping side two tertiary radials, which gives to each of these rays three arms. In the ray opposite the azygous area the third primary radial supports upon each upper sloping side three secondary radials which gives to this ray two arms. There are, therefore, sixteen arms in this species. The arm formula is 4+4+3+3+2.

The interradial areas are substantially alike. The first interradials are the largest plates in the calyx, have nine sides, and are truncated above for the second interradial, which is rather less than half as large as the first. It is followed in the third range by a small plate that unites with two plates belonging to the vault.

The vault is convex, elevated over the ambulacral canals and concave in the interambulacral areas, and bears a short subcentral proboscis, at the summit of which is the azygous orifice. The plates are large, covered with granules, and each one bears a central tubercle except the two elongated plates in concave depression in each interambulacral area. There are two ovarian apertures between each ray, and also between each double ray and the single rays, which arrangement gives to the species twenty ovarian apertures. This species is distinguished by its general form and surface ornamentation from all other sixteen-armed species. It is also distinguished from *D. cœlatus* and all species except *D. salebrosus* by the arm formula. The arm formula is like *D. salebrosus*, but that species has a concave depression below, and is constricted below the arms, and has two interradials in the second range, and very different surface ornamentation. This species cannot be mistaken for any other, either upon superficial examination or upon close inspection of the number and arrangement of the plates.

Found by Geo. K. Greene in the Hamilton Group, near Charlestown, Indiana, and now in the collection of Wm. F. E. Gurley.

DOLATOCRINUS DISSIMILARIS, n. sp.

Plate III, Fig. 25, basal view; Fig. 26, summit view, Fig. 27, azygous side view.

Species below medium size, depressed or very short. Calyx low, about three times as wide as high, rounding out from a deep basal cavity and spreading, without any constriction below the arms and having the general form of *D. aplatus*. Surface deeply sculptured. Radial ridges very small and nodes small. The central part of each interradial instead of bearing a node is excavated.

Basal plates within the cavity of the calyx and extend higher than the base of the free arms, funnel-shaped. First primary radials within the funnel-shaped basal cavity and longer than wide. Second primary radials about twice as wide as long, quadrangular. Third primary radials a little larger than the second, twice as wide as long, pentagonal, axillary, and in each ray adjoining the azygous area and in the ray opposite the azygous area support on one of the upper sloping sides three secondary radials and upon the other a single secondary radial, which is axillary and supports on each upper sloping side two tertiary radials, which arrangement gives to each of these rays three arms. In each of the other lateral rays the third primary radials support on each upper side three secondary radials which give to each of these rays two arms. There are, therefore, thirteen arms in this species. It is the proximal side of each ray adjoining the azygous area that bears the tertiary radials.

The azygous area is like the other areas. The first plate is somewhat elongated, has nine sides and is truncated by a single plate, less than one-fourth as large, in the second range. There is one small plate in the third range, that unites with two plates belonging to the vault.

The vault is quite evenly convex, has small ridges over the ambulacral canals and bears a small, short, almost central proboscis. The sutures cannot be distinguished, in our specimen, and the surface is eroded so the ornamentation is not shown, in the illustrations. There are four ovarian apertures to each ray, or twenty in the the species, all of which are elongated and enter the vault instead of the ambulacral canals.

This species in its general form resembles *D. aplatus*, but that species has fifteen arms while this one has thirteen so the arm formula alone will distinguish them. The only species with which this one agrees, in the arm formula, is *D. lyoni* above described but the species are readily distinguished by the general form and surface ornamentation as well as by the interradials. It is not necessary to make any comparison with any other species.

Found by J. F. Hammell in the Hamilton Group, near Charlestown, Indiana, and now in the collection of Wm. F. E. Gurley.

DOLATOCRINUS PECULIARIS, n. sp.

Plate III, Fig, 28, azygous side; Fig. 29, basal view; Fig. 30, summit.

Species above medium size but very short. Calyx broadly and deeply concave below and slightly constricted below the arms. Radial ridges very inconspicuous, and interrupted at the sutures.

The plates are very tumid and radiately furrowed toward the margins. The surface ornamentation resembles that of *D. vasculum* and there is much resemblance in the general form of the two species, but that is an eighteen-armed species and this is a seventeen-armed one. Column small but having a comparatively large cinquefoil canal.

Basals deeply sunken in the concavity so as to extend higher than the base of the arms. The hollow cone thus formed is not entirely filled by the end of the column and the basal disc may be seen having a diameter one-half greater than the diameter of the column. First primary radials as long as wide and entirely within the basal concavity and forming part of the funnel shaped depression. Second primary radials form part of the basal concavity, a little wider than long, quadrangular and the calyx will rest on the central nodes of the first interradials and these plates. Third primary radials curve upward, nearly as long as wide, pentagonal, axillary, and in the ray on each side of the azygous area, bear upon each upper sloping side a single secondary radial which is axillary and bears upon each upper side two tertiary radials, which gives to each of these rays four arms. In each of the other three rays the third primary radial bears upon one upper sloping side three secondary radials, and upon the other one secondary radial, which is axillary and supports upon each upper sloping side two tertiary radials, which gives to each of these three rays three arms. There are, therefore, seventeen arms and seventeen ambulacral openings to the vault in this species. It will be observed that the arm formula is the same that is found in *D. bellulus.*

The interradial areas are not alike, in this species, and the azygous area is smaller than either of three of the others. The first interradials are the largest plates in the calyx, the lower half of each bends into the basal concavity from the middle part and upward at the superior end. In the azygous area and in one of the other areas, it is followed by a single plate, in the second range, about one-fourth as large, and it is followed, in the third range by a smaller plate that unites with the plates of the vault. In the other areas the second interradial is smaller and is followed by two plates in the third range and these are followed by a single plate in the fourth range that unites with the plates of the vault. The plates in the interradial areas thus vary from three to five.

The vault is only moderately convex, depressed in the interambulacral areas, and covered with large tubercular plates. The sutures between the plates are not shown, in the illustrations, because only part of them can be distinguished, in our specimen. The proboscis or short tube for the azygous orifice is excentric, from the azygous side, which is a peculiarity not often observed among the crinoids. There is a large central plate between the tube for the orifice and the azygous area. Notwithstanding these peculiarities, we have no doubt that we are correct in placing the azygous area between the four armed rays. There are four ovarian apertures between each of the rays and two between each of the arms which arrangement gives to the species forty-four ovarian apertures.

This is a remarkable and extraordinary species readily distinguished from all others, though at first glance resembling D. *vasculum* and having the arm formula of *D. bellulus*, 4+3+3+3+4, a species with which it agrees in no other respect. It is not abnormal.

Found by George K. Greene in the Hamilton Group, near Charlestown, Indiana, now in the collection of Wm. F. E. Gurley.

FAMILY TAXOCRINIDÆ.

FORBESOCRINUS GREENEI, n. sp.

Plate IV, Fig. 25, azygous side view; Fig. 2, basal view, showing part of the column broken down.

Species very large; radial series not elevated beyond the interradial areas; plates flattened or slightly convex; sutures beveled. The plates do not overlap, as is usual in this genus, nor does the column taper as rapidly, below the calyx, as usual.

Basals within the calyx. Subradials wide and only partly exposed. Primary radials four in each series and from two to four times as wide as long. They are directed at an angle of about 45 degrees, so as to give the lower side of the calyx a broadly rounded outline, that is continued into the tertiary series of plates where the calyx has its greatest diameter. The last primary radial in each series is longer than those below it, pentagonal, axillary, and has rather steep upper sloping sides upon which it supports the secondary radials. There are three secondary radials in each of eight series and two in the other two series. The proximal series on the left of the azygous area has only two secondary radials and the distal series, in the ray, on the right of the azygous area, has only two secondary radials. The secondary radials, though of unequal size, are not much smaller than the primary radials.

The last ones are axillary and support, on the upper sloping sides, the tertiary radials. The tertiary radials vary in number in the different rays that are preserved, in our specimen, from four to six, but all the series are not preserved, and hence the variation may be greater. There are only a few plates preserved in the quaternary series, so that any definition of them will be of no special service, though the total number of arms is necessarily forty and probably sixty.

The regular interradial areas are of unequal size, more or less elongate-ovate and covered with large plates. All of the areas are not preserved in our specimen, but in those preserved there are from sixteen to twenty plates. The intersecondary areas are much elongated and have numerous plates. The intertertiary radial areas are also elongated and have three or more plates following each other. In the azygous area an heptagonal plate broadly truncates a subradial. It is followed by two plates in the second range, three in the third, four in the fourth, three in the fifth, three in the sixth, three in the seventh, two in the eighth, two in the ninth, and above these they are not preserved in our specimen, but as these twenty-three plates do not extend as high as the intersecondary or intertertiary plates, it is evident that the total number will be found to be from twenty-seven to thirty.

This species is distinguished by its rounded massive form, transverse or slightly concave beveled sutures, elongated interradial, intersecondary, and intertertiary areas, and by the structure of the azygous area. It will throw no light upon it to contrast it with other species, for it can always be distinguished on the slightest observation.

Found by Geo. K. Greene, in whose honor the specific name is given, in the Keokuk Group, at Edwardsville, Indiana, and now in the collection of Wm. F. E. Gurley.

FORBESOCRINUS MACADAMSI, n. sp.

Plate V, Fig. 1, azygous side; Fig. 2, opposite view of the same specimen.

Species very large. Radial series prominent and interradial areas depressed so as to give the calyx a marked quinquelobate outline as seen from below. Plates rounded in the radial series and slightly convex in the interradial spaces. Sutures only moderately concave and slightly beveled. The plates overlap very little, and the column, which is composed of thin plates, tapers slowly from the calyx.

Basals covered by the column. Subradials wide and only partly exposed. Primary radials, five in one of the lateral rays and four in each of the other rays. The first one is longer than either of the others and they vary from two to four times as wide as long. The last primary radial in each series is pentagonal, axillary, and supports the secondary radials. There are four secondary radials in each series in the ray on the right of the azygous area, and three secondary radials in each of the other eight series. The last secondary radial in each series is axillary and supports the tertiary radials. The tertiary radials vary in number in the different rays, as may be seen in the illustrations, from four to nine, and the last one is axillary and supports a quaternary series. Another division takes place in the distal arms in each ray, so as to give to each ray twelve arms. The arms infold at the superior end and some of them again divide, but exactly how many our specimen does not disclose. There are, therefore, more than sixty arms in this species.

The regular interradial areas are of unequal size, long, and lanceolate in outline. In one area there are fourteen plates, in another seventeen, and in another twenty. The intersecondary radial areas are lanceolate and differ very greatly in size. In the one opposite the azygous area there are two elongated plates. In the one on the right of the azygous area there are nineteen plates and in the one on the left of the azygous area there are eight plates. In the intertertiary radial area on the right of the azygous area there are two elongated plates, one following the other, but there are no other intertertiary plates in our specimen. The ray on the right of the azygous area is larger than either of the other rays, more protuberant and contains more intersecondary plates beside the two intertertiary plates. The azygous area is wider and contains more plates than either of the regular areas and is also lanceolate in outline. The first azygous plate broadly truncates a subradial and is followed by two plates in the second range, one of which only truncates it slightly on the left and the other broadly on the right and is followed by a longitudinal series of six or seven plates as disclosed between the arms, and, on the right of this series, and separated from it by a nearly straight suture, there is a longitudinal series of seven plates; on the left and separated by a longitudinal suture there are nine plates in a double series, arranged with some irregularity. There are, therefore, as many as twenty-five or twenty-six plates in this area. It will be seen that if the distinction between *Taxocrinus* and *Forbesocrinus* is dependent upon the azygous area that we have here a *Taxocrinus* by reason of the longitudinal series of plates, and a *Forbesocrinus* by reason of the large area.

This species will be readily distinguished by its quinquelobate form, number of primary and secondary radials and shape of the interradial areas and by the azygous plates.

Found by the late Wm. McAdams, in whose honor the specific name is given, in the Keokuk Group, in Jersey county, Illinois, and now in the collection of Wm. F. E. Gurley.

FAMILY PLATYCRINIDÆ.

PLATYCRINUS FORMOSUS, var., APPROXIMATUS, n. var.

Plate IV*, *Fig. 8*, *basal view; Fig. 9*, *summit view*; *Fig. 10*, *azygous side view; Fig. 11*, *opposite side.

This species or variety is medium size and belongs to the discoid forms. It is so much like *P. formosus* that it can only be called a variety, in the absence of a knowledge of the vault of that species, and, if the vaults are alike then the varietal name may be stricken out, but if the vaults are differently constructed then the varietal name may have the rank of a species. The calyx is shallow, though deeper than in the types of *P. formosus*, pentagonal, three times as wide as high. Plates thick and bearing low rounded nodes less conspicuous than they are in the types of *P. formosus*. Sutures beveled but not canaliculate as they are in *P. formosus*.

Basals form a concave pentagonal disc bordered by a nodose rim. The first radials are rounded upward from the basal suture and constricted in the middle part, beyond which they are directed horizontally, and the facet for the second plate is nearly perpendicular. Each articulating facet forms more than half a circle and has a diameter about one-half the diameter of the plate and is slightly notched for the ambulacral canal.

The angles for the reception of the regular interradials are somewhat acute, and the interradials are longer than wide and stand upright, so as to elevate the vault, and give to the whole body a pentagonal, subglobose outline. The first azygous plate is not as long as the first regular interradials, but a little wider, and bordered at the upper part of each side by an interradial which gives to the azygous area greater width than is found in the other areas, and it is surmounted with two small plates that form part of the rim surrounding the azygous opening.

The vault is abruptly elevated over the calyx so as to retain the pentagonal outline, with concave sides, and so as to have a capacity greater than that of the calyx. It is convex on top and covered with a few large, polygonal, subspinous plates. The largest plate is subcentral on the azygous side and surrounded by nine plates. The azygous orifice is large and situated between the ambulacral openings, though not extending quite so low. It is surrounded by eight plates.

The calyx of this species or variety, as the case, in fact, may be, is not as concave below, as it is in *P. formosus*, and the calyx in that species is four times as wide as high, while, in this, it is only three times as wide as high. The sutures are canaliculate in that species, and beveled in this. The angles of the interradials are more acute in this variety than in that, and appearances indicate that the vault in *P. formosus* is lower than it is in this. If, however, the vaults are alike, this is merely a varietal form of *P. formosus*, unless the difference between the canaliculate and beveled sutures is of specific importance: for the difference in form may exist, in the same species. If, again, this form shall, in future, be referred to *P. formosus*, we are fully justified in publishing it as a varietal form, because we have a complete specimen differing in some respects, from the type, so far as it was preserved.

Found in the Burlington Group, at Sedalia, Missouri, and now in the collection of F. A. Sampson.

PLATYCRINUS SUBSCITULUS, n. sp.

Plate IV, Fig. 12, basal view; Eig. 13, summit view; Eig 14, azygous side; Fig. 15, opposite side.

Species medium or rather below medium size, calyx and vault subequal, in capacity, and it belongs to the discoid forms. Calyx discoid, subpentagonal, about three times as wide as high. Surface without ornamentation, granular, sutures beveled.

Basals form a pentagonal disc with a concave depression toward the central part, where the column attached. The beveled suture surrounding the disc will allow the calyx to rest on the rim of the disc surrounding the concave depression. First radials are directed upward at an angle of about forty-five degrees and are convex toward the facet for the second radials, which is concave and occupies a little more than one-third of the diameter of the plates, and is a little more than half a circle. The second radials are short, constricted, directed horizontally and axillary.

The interradial areas are depressed so as to leave the form pentagonal when seen from above. The interradials are elongated, and instead of rising perpendicularly from the calyx are inclined inward so as to contract the vault in the interradial areas.

Vault elevated over the ambulacral canals and depressed in the ambulacral areas so as to leave only a slight convexity centrally. The plates of the vault are subspinous. A large plate is situated subcentrally on the azygous side and surrounded with seven plates, six of which are subspinous. The azygous orifice is situated between the ambulacral openings, and the first azygous plate is shorter and smaller than the first regular interradials. The orifice is surrounded by eight plates.

This species is distinguished by its general form, freedom from surface ornamentation of the calyx, quinquelobate aspect as seen from above, projecting second radials, and the limited number of plates on the vault.

Found in the Burlington Group, at Sedalia, Missouri, and now in the collection of F. A. Sampson.

PLATYCRINUS CONCINNULUS, n. sp.

Plate IV, Fig. 16, azygous side; Fig. 17, opposite view; Fig. 18, summit view.

Species medium or above medium size. Calyx urn-shaped, rounded below, slightly projecting at the arms so as to give it a subpentagonal outline when seen from above, and about one-fourth wider than high. Surface finely granular. Sutures slightly beveled. Column round.

Basals form a low, rounded cup, pentagonal at the top, and bear a slight constriction or furrow in the middle part above the end of the column. First radials expand slightly and are a little longer than wide. They are convex toward the facets for the second radials. A facet occupies a little more than one-third the diameter of the plate and is semi-circular in outline, and notched for the ambulacral canal. The second radials are very short and axillary, giving ten arms to the species.

The regular interradials are rather large and curve abruptly over on the vault. The azygous interradial stands nearly upright and forms one side of the base of the proboscis.

Vault low, nearly flat, and covered with a few convex and subnodose plates. A highly nodose plate covers the junction of the ambulacral canals at the base of each arm. The base of the proboscis is large and subcentral, but the height is unknown.

The lower part of the calyx of this species resembles *P. concinnus*, but the vaults are altogether different, and that species has eighteen or twenty arms, and this one has only ten. The constriction around the basal plates will distinguish this species from nearly all the urn-shaped species, and none that have been described have a vault similar to this one.

Found in the Burlington Group, at Sedalia, Missouri, and now in the collection of F. A. Sampson.

FAMILY CARYOCRINIDÆ.

CARYOCRINUS MILLIGANÆ, n. sp.

Plate V, Fig. 3, azygous side view; Fig. 4, summit.

Species medium to large size, rapidly spreading to the middle of the second range of plates, where it has an hexagonal outline, then lengthens above and contracts into a comparatively small triangular summit. Ridges radiate from the center of each plate to the angles, except on the basal plates, where the ridges run from the superior angles to the point of columnar attachment. There is a single or double row of pores accompanying these ridges, but none elsewhere on the plates.

The basal plates are of unequal size and form an angular, hexagonal cup rather more than one-fourth the length of the body. The six plates in the second range are of unequal size, two are pentagonal, two hexagonal and two heptagonal. These plates are protuberant at the central part, some of them pyramidal, so that a transverse section at this place is hexagonal. There are eight elongated plates in the third range, of unequal size and different in outline. The general form of six of these plates is pentagonal and the other two quadrangular, but the small plates belonging to the vault change the number of sides so that the subquadrangular plates become hexagonal and the subpentagonal plates become heptagonal, octagonal and nonagonal.

The summit is subtriangular, flat centrally, and the plates turn over the margin in some places and in others stand up over the arm openings so as to hide them from a summit view. The vault is covered with a large central plate surrounded by eight plates and a few small plates around the orifices at the angles of the triangular summit. One of the circle of eight plates abuts against a subquadrangular plate belonging to the third range of body plates at the middle of one side of the triangle and another at the middle of another side, and another against a subpentagonal plate near the middle of the other side and adjoining the mouth. The mouth is a round orifice surrounded by five plates. It is situated near the middle of one of the sides of the triangle, and truncates the angles of two of the third range of body plates, two of the plates belonging to the circle of eight plates on the summit abut upon it, and one plate inserted between the third range and the circle of eight plates abuts against it. The illustration of the azygous side view shows the mouth and the plates surrounding it. The plate on the left is the one intercalated between the range and circle of plates.

The arms are divided into three clusters, which are located at the angles of the summit. There are three arm openings at one of the angles and two at each of the others. The three-armed angle is opposite the mouth. There are, therefore, seven arms in this species. The plate over each arm opening bears a node and there is a small plate between each of the arm openings.

This species is distinguished by its general form from all others. The triangular summit is peculiar and the arrangement of the seven arms at the angles is different from that in any other described species.

Found by Mrs. J. M. Milligan, in whose honor we have proposed the specific name, in the Niagara Group, in Decatur county, Tennessee, and the specimen illustrated is now in her collection. The species is also represented in the collection of each of the authors, though the type is the best preserved and shows the sutures between the plates better than our specimens do.

CARYOCRINUS HAMMELLI, n. sp.

Plate V, Fig. 5, azygous side view, Fig. 6, summit.

Species large, subelliptical in outline, the angular convexity, at the middle of each plate, in the second range, gives an hexagonal outline to the middle part of the body. The summit is irregularly subcircular or suboctagonal. Ridges radiate from the center of each plate to the angles, in the form of coalescing nodes, except on the basal plates, where the ridges run from the superior angles toward the point of columnar attachment. There is a single or a double row of pores accompanying these ridges and there are nodes and pores on other parts of the plates.

Three of the basal plates are about equal in size, but the other one is nearly twice as large as either of them. The large plate is hexagonal in outline, and the others are quadrangular. They form an hexagonal cup about one-third the length of the body. The six plates in the second range are of unequal size, and the larger ones follow the smaller basal plates so that the symmetry of the body is restored; two are pentagonal, two hexagonal, and two heptagonal. They are longer than the plates in either of the other ranges. There are nine plates in the third range, and, as they are different from those in other species, we will call particular attention to them, by commencing at the one at the azygous orifice and following the range to the right. One abuts the middle upon the azygous orifice and each lateral side on a summit plate at the superior end, which make the plate heptagonal. The next one abuts two summit plates and is hexagonal. The next four summit plates and is heptagonal because there are only three sides below the summit. The next one also abuts four summit plates and is heptagonal, but one of the four summit plates belongs to the circle that surrounds the central summit plate. The next one is hexagonal, very wide below and narrow above and abuts two summit plates. The next one is hexagonal and abuts two summit plates. The next one has ten sides and abuts the superior end against seven summit plates one of which belongs to the circle that surrounds the central summit plate. The next one has ten sides and abuts six summit plates or those surrounding the ambulacral orifices, and the next one abuts three plates belonging to the summit and is heptagonal.

The central summit plate is surrounded by a circle of seven plates, two of which abut upon the plates of the third range, as above described, and between these two plates there is a cluster of arms opposite to the mouth. The mouth is depressed below the level of the summit and is surrounded by six plates, two of which belong to the circle of seven plates and one belongs to the third range of body plates. The two plates that abut upon the plates belonging to the third range, are also depressed below the level of the summit, and the vault is thus divided into three areas which contain the arm clusters and the smaller summit plates about the orifices.

There are five arm openings in the cluster opposite to the mouth, four in the cluster on the right of the mouth and eight in the cluster on the left of the mouth. There are, therefore, seventeen ambulacral openings in this species.

This species is distinguished by its general form, by having nine plates instead of eight or less in the third range and by the form of the summit and number of arms.

Found in the Niagara Group, in Madison county, Indiana, by J. F. Hammell, in whose honor we have proposed the specific name and now in his collection.

PLATE I.

Page.

Batocrinus nodosus, n. sp. 5
Fig. 1. Azygous view.
Fig. 2. Opposite side view.
Fig. 3. Summit.

Batocrinus nodulosus, n. sp 6
Fig. 4. Basal view.
Fig. 5. Azygous view.
Fig. 6. Opposite side view.

Agaricocrinus adamsensis, n. sp 24
Fig. 7. Azygous view.
Fig. 8. Summit.
Fig. 9. Basal view.

Batocrinus salemensis, n. sp 8
Fig. 10. Basal view.
Fig. 11. Summit.
Fig. 12. Azygous view.

Batocrinus stelliformis, n. sp 9
Fig. 13. Basal view
Fig. 14. Azygous view.
Fig. 15. Summit.

Batocrinus signatus, n. sp 10
Fig. 16. Azygous view.
Fig. 17. Opposite side view.

Batocrinus strenuus, n. sp 11
Fig. 18. Azygous view.
Fig. 19. Opposite side view.

Batocrinus delicatulus, n. sp 12
Fig. 20. Azygous side view, magnified two diameters.
Fig. 21. Opposite side view of same.

Batocrinus regalis, n. sp 14
Fig. 22. Basal view.
Fig. 23. Azygous view.
Fig. 24. Summit.

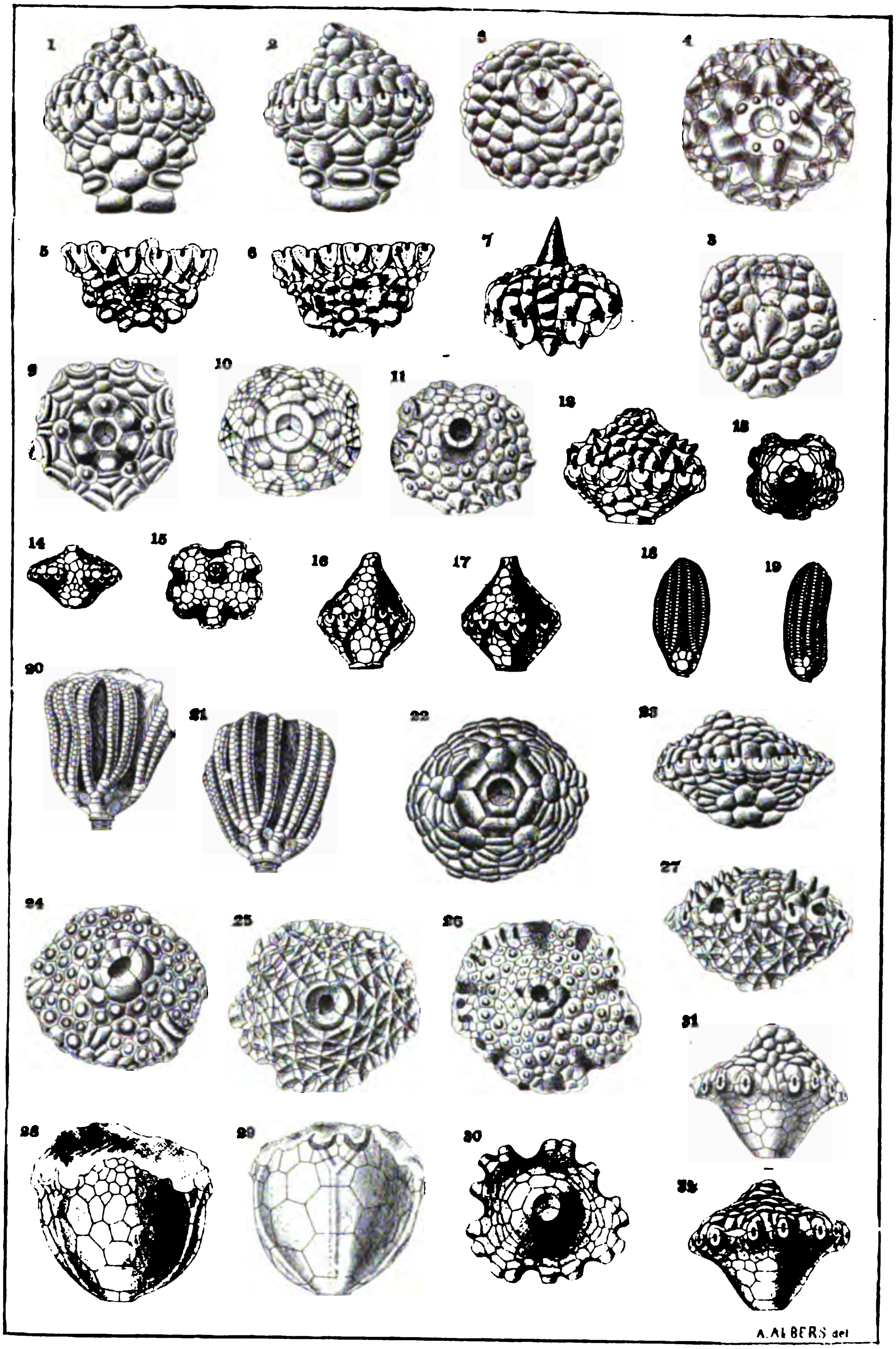
Actinocrinus poLLUBRUM, n. sp 25
Fig. 25. Basal view.
Fig. 26. Summit.
Fig. 27. Azygous view.

Amphoracrinus sampsoni, n. sp 27
Fig. 28. Azygous view.
Fig. 29. Opposite side view.

Batocrinus nitens, n. sp 15
Fig. 30. Basal view.
Fig. 31. Azygous view.
Fig. 32. Opposite side view.

ILL. STATE MUS. OF NAT. HIST.

Bulletin No. 9. **Plate I.**



A. ALBERS del

PLATE II.

Page.

Batocrinus parilis, n sp 17

Fig. 1. View of calyx and arms.
Fig. 2. Azygous view of calyx.

Batocrinus faberi, n sp 18

Fig. 3. Azygous view.
Fig. 4. Opposite side of same.

Batocrinus pettisensis, n. sp 19

Fig. 5. Azygous view.
Fig. 6. Opposite side of same.

Batocrinus spurious, n. sp 20

Fig. 7. One of the azygous areas.
Fig. 8. View of the other azygous area.
Fig. 9. Opposite side of same.

Barycrinus neglectus, n. sp 25

Fig. 10. Azygous view.
Fig. 11. Opposite view of same.
Fig. 12. Lateral view of same.

Agassizocrinus ovalis, n. sp 26

Fig. 13. View of calyx and arms.
Fig. 14. Azygous view of another calyx.

Poteriocrinus albersi, n. sp 29

Fig. 15. Azygous view of calyx and arms.
Fig. 16. Opposite side of same.
Fig. 17. Basal view of same, magnified two diameters.

Poteriocrinus lautus, n. sp 30

Fig. 18. Azygous view of calyx and arms.
Fig. 19. Opposite side of same.

Rhodocrinus blairi, n. sp 32

Fig. 20. Basal view of calyx.
Fig. 21. Azygous view of same.
Fig. 22. Opposite side of same.
Fig 23. Summit. All figures magnified two diameters.

Cyathocrinus chouteauensis, M. & G 33

Fig. 24. View opposite azygous side, magnified two diameters.

Scaphiocrinus notatus, n. sp 34

Fig. 25. Azygous view.
Fig. 26. Opposite side of same.

Dolatocrinus dispar, n. sp 40

Fig. 27. Lateral view.
Fig. 28. Basal view.
Fig. 29. Summit.

Dolatocrinus preciosus, n. sp 41

Fig. 30. Basal view.
Fig. 31. Summit.
Fig 32. View opposite azygous side.

ILL. STATE MUS. OF NAT. HIST.

Bulletin No. 9. **Plate II.**

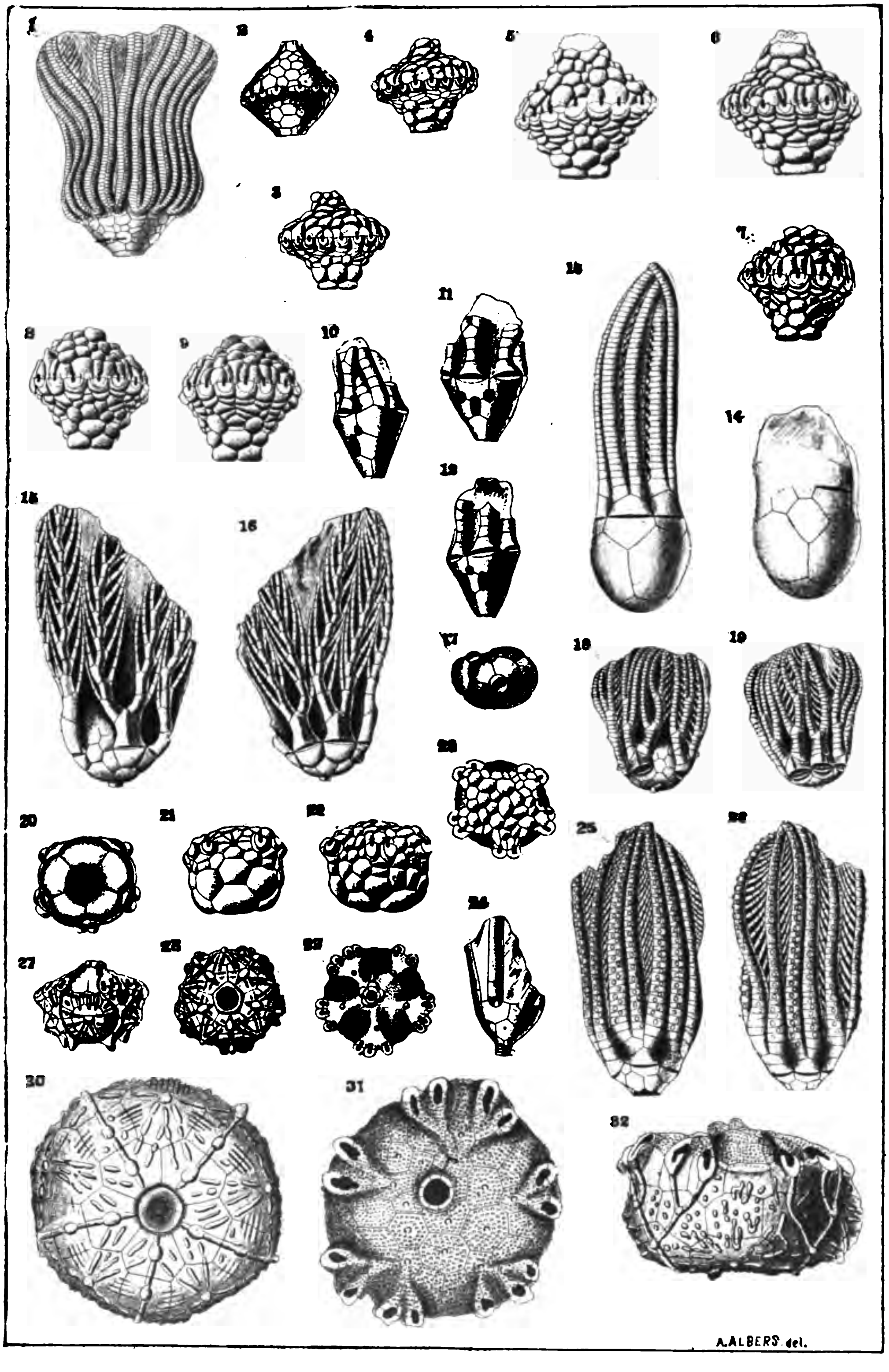


PLATE III.

Page.

DOLATOCRINUS BASILICUS, n. sp 43

Fig. 1. Basal view.
Fig. 2. Summit.
Fig. 3. Lateral view.

DOLATOCRINUS LYONI, n. sp 44

Fig. 4. Summit.
Fig. 5. Basal view.
Fig. 6. Azygous view.

DOLATOCRINUS CISTULA, n sp 46

Fig. 7. Basal view.
Fig. 8. Summit.
Fig. 9. Lateral view.

DOLATOCRINUS ASPER, n. sp 47

Fig. 10. Basal view.
Fig. 11. Summit.
Fig. 12. Azygous view.

DOLATOCRINUS APLATUS, M. & G 49

Fig. 13. Basal view.
Fig. 14. Summit.
Fig. 15. Lateral view.

DOLATOCRINUS ASPRATILIS, n. sp 49

Fig. 16. Basal view.
Fig. 17. Summit.
Fig. 18. Azygous view.

DOLATOCRINUS LAGUNCULA, n. sp 51

Fig. 19. Basal view.
Fig. 20. Lateral view.
Fig. 21. Summit.

DOLATOCRINUS ARROSUS, n. sp 52

Fig. 22. Basal view.
Fig. 23. Azygous view.
Fig. 24. Summit.

DOLATOCRINUS DISSIMILARIS, n. sp 54

Fig. 25. Basal view.
Fig. 26. Summit.
Fig. 27. Azygous view.

DOLATOCRINUS PECULIARIS, n. sp 55

Fig. 28. Azygous view.
Fig. 29. Basal view.
Fig. 30. Summit.

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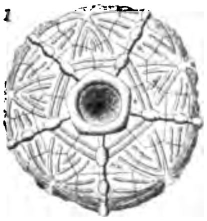
Bulletin No. 9. Plate III.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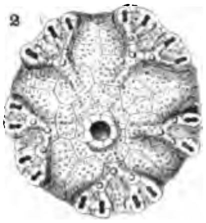
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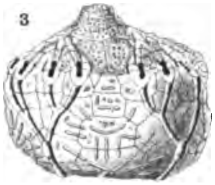
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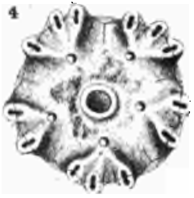
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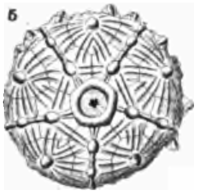
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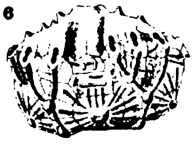
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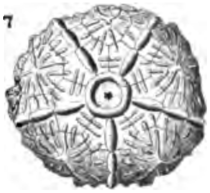
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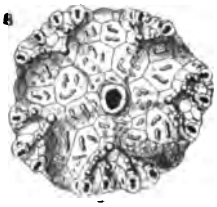
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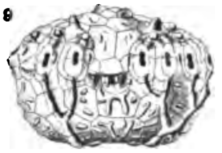
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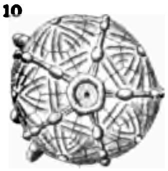
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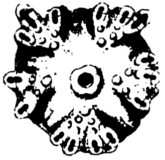
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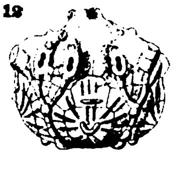
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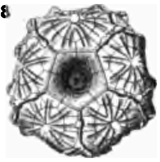
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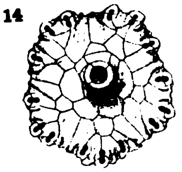
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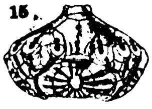
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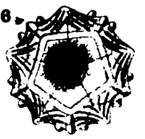
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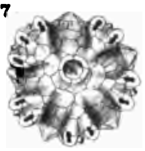
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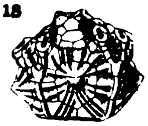
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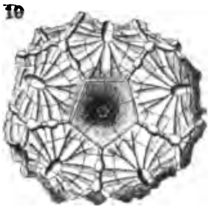
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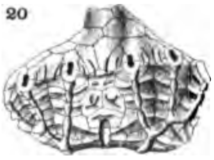
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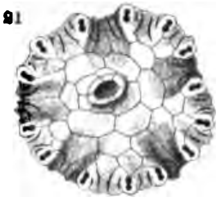
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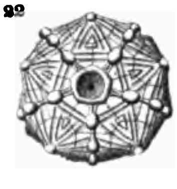
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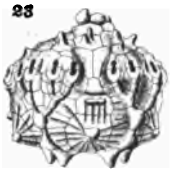
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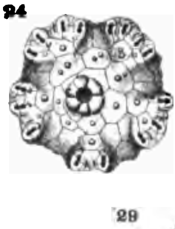
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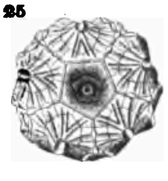
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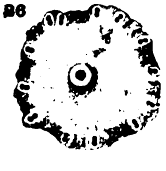
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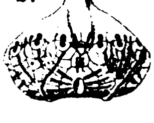
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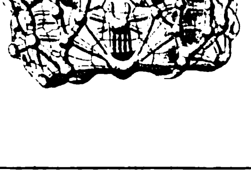
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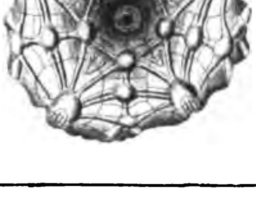
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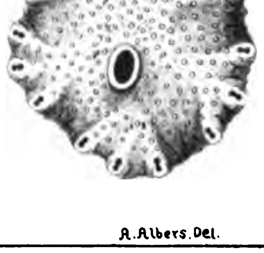
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PLATE IV.

Page.

Forbesocrinus greenei, n. sp. 57

Fig. 1. Azygous view.
Fig. 2. Basal view.

Poteriocrinus neglectus, n. sp. 31

Fig. 3. Lateral view azygous area on the right.
Fig. 4. Lateral view, azygous area on the left.
Fig. 5. Azygous view.

Poteriocrinus arrectarius, n sp. 33

Fig. 6. Azygous view.

Poteriocrinus labyrinthicus, S. A. M 34

Fig. 7. Azygous view.

Platycrinus formosus, var. approximatus, n. var. 60

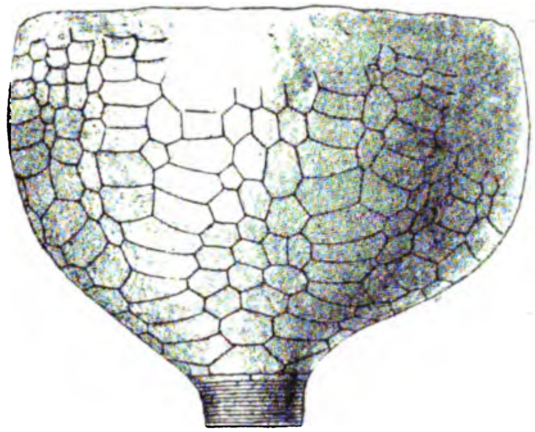
Fig. 8. Basal view.
Fig. 9. Summit.
Fig. 10. Azygous view.
Fig. 11. Opposite side view.

Platycrinus subscitulus, n sp 62

Fig. 12. Basal view.
Fig. 13. Summit.
Fig. 14. Azygous view.
Fig. 15. Opposite side view.

Platycrinus concinnulus, n. sp. 63

Fig. 16. Azygous view.
Fig. 17. Opposite side view
Fig. 18. Summit.



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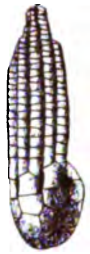

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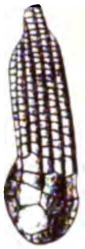

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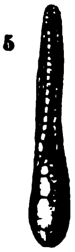

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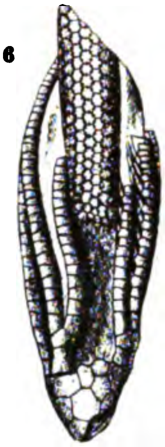

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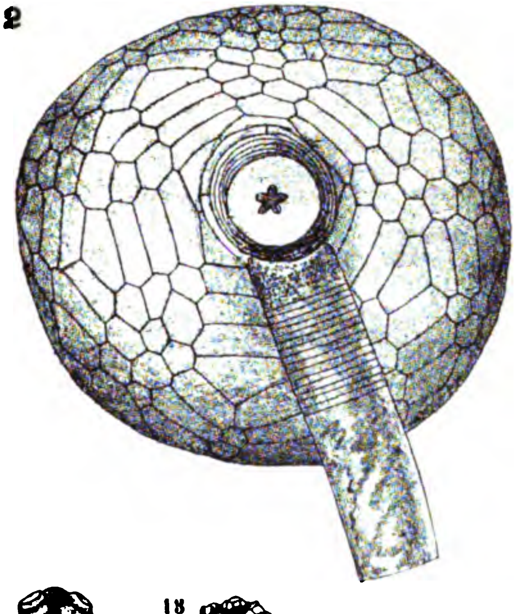

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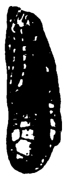

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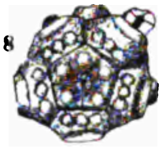

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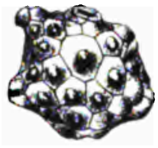

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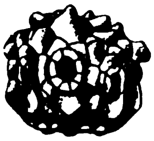

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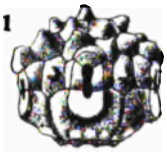

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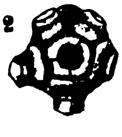

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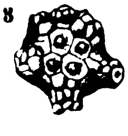

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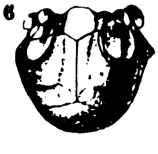

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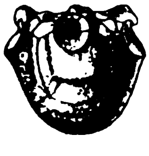

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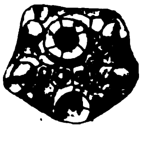

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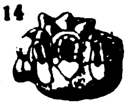

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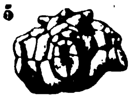


PLATE V.

Page.

FORBESIOCRINUS MACADAMSI, n. sp 58

Fig. 1. Azygous view.
Fig. 2. Opposite side view.

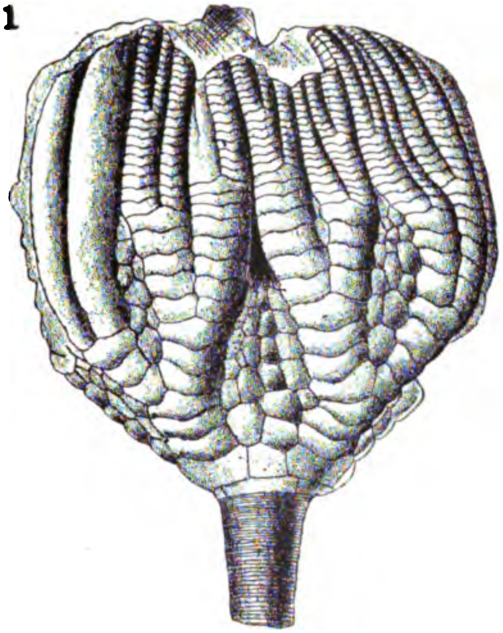
CARYOCRINUS MILLIGANÆ, n. sp 63

Fig. 3. Azygous view.
Fig. 4. Summit.

CARYOCRINUS HAMMELLI, n. sp 65

Fig. 5. Azygous view.
Fig. 6. Summit.

1



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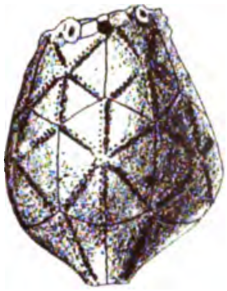

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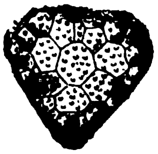

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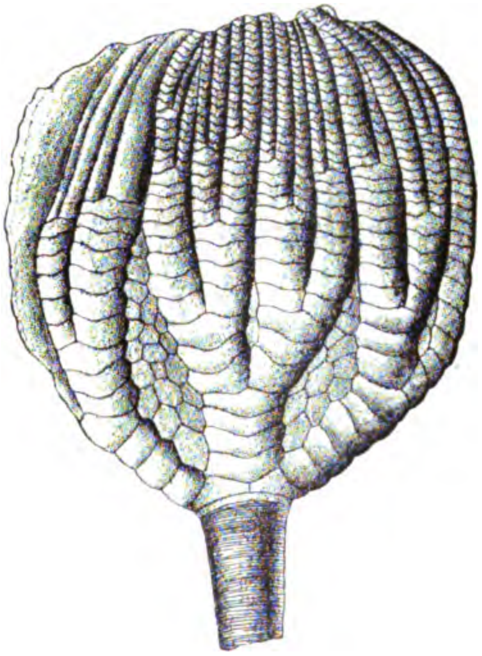

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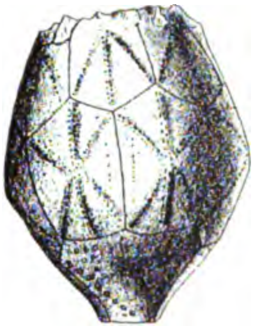

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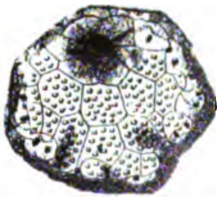

A. ALBERS del.